UNIVERSIDAD POLITÉCNICA
DE MADRID

ESCUELA TÉCNICA SUPERIOR DE INGENIEROS INFORMÁTICOS

MÁSTER UNIVERSITARIO EN INGENIERÍA DEL SOFTWARE –
EUROPEAN MASTER ON SOFTWARE ENGINEERING

ITIL in Small to Medium-Sized Enterprises: Toward a Proposal Based on an ITIL Processes Implementation Sequence and a Profile Scheme Strategy for Implementing the First Process in the Sequence.

Master Thesis

Lohana Mariella Lema Moreta

Madrid, June 2015

This thesis is submitted to the ETSI Informáticos at Universidad Politécnica de Madrid in partial fulfillment of the requirements for the degree of Master of Science on Software Engineering.

Master Thesis
Master Universitario en Ingeniería del Software – European Master on Software Engineering
Thesis Title: ITIL in small to medium-sized enterprises: toward a proposal based on an ITIL processes implementation sequence and a profile scheme strategy for implementing the first process in the sequence.
Thesis no: EMSE-2015-01
June 2015

Author: Lohana Lema Moreta
Multimedia System Computer Engineering
Escuela Superior Politécnica del Litoral - Ecuador.

Supervisor:

Jose Antonio Calvo-Manzano
Phd. Computer Science.
Universidad Politécnica de Madrid

Lenguajes y Sistemas Informáticos e Ingeniería de Software
Escuela Técnica Superior de Ingenieros Informáticos
Universidad Politécnica de Madrid.

ETSI Informáticos
Universidad Politécnica de Madrid
Campus de Montegancedo, s/n
28660 Boadilla del Monte (Madrid)
Spain

ACKNOWLEDGMENTS

I would like to express my utmost thanks to Dr. Dn. Jose Antonio Calvo-Manzano, my thesis supervisor, for his motivation, guidance, time and support. Without his patient support this research would have been difficult to execute.

Thanks so much to my professors who showed their comprehension and advice when difficult times were presented during my studies.

My foremost gratitude to the government of Ecuador who allowed me to obtain through the scholarship program, the financial support for my studies.

Finally, I would like to thank my family and friends; specially my mother, my father, my brother, my niece and my fiancé. They unconditionally accepted the sacrifice of changing our lives during the last two years; their daily support, love and sympathy are my fuel.

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CHAPTER 1
INTRODUCTION

In this chapter, the backdrop of actual problematic about the implementation of Information Technology (IT) services management in Small and Medium Enterprises (SMEs) will be described. Throughout the chapter, it will be exposed the reasons why reaching a maturity/capability level through well-known standards or the implementation of good software engineering practices by means of IT infrastructure Library are really difficult to achieve by SMEs. Also, the solutions to the exposed problems will be explained. Also master thesis goals are presented in terms of: purpose, research questions, research goals, objectives and scope. Finally, thesis structure is described.

1.1 Context

During the last two decades, software industry has emerged as a very significant economic activity around the world. As a consequence, countless micro, small and medium-sized enterprises (SMEs) are being created, which are becoming in a major economic force in many countries and moreover they are considered by other industries as a valuable provider of products and services (Pino, García, & Mario, 2008) (Estayno, Dapozo, Greiner, Cuenca, & Pelozo, 2009).

Independently of the industry where SMEs have been created, the presence of Information Technology (IT) area inside enterprises structure has become imperative. At the beginning, the IT department was responsible to perform specific technical tasks related to servers, networks, technical support, hardware upgrade, and installation and development of in house applications; but over time, despite these responsibilities have not changed, demands of their different final users have increased. Thereby, it is not surprising that enterprises increase their IT investments in order to achieve a strategic advantage in the market, even though each enterprise values the relation between IT and business in a different way. For instance, 13% of enterprises surveyed by Huang in 2007 (Huang, 2007) considered IT as a core of their business, whereas 34% of enterprises did not considered IT as their central business but they considered IT investment as an important factor to improve their whole business operation.

Despite these tasks are contributing to resolve problems and accomplish enterprise computational requirements (computers become more cheaper and more powerful over time), the business value of technology should not be limited by computational capability, otherwise it should be limited by the ability of managers to invent or follow processes, procedures, practices and organizational structures that leverage this capability (Brynjolfsson & Hitt, 2000). In other words, IT providers can no longer afford to focus its operation only on technology; they must take into account the quality of services they provide and relationship with customers (Conger, Gallup, Dattero, & Quan, 2007). The discipline that focuses on managing these approaches is called Information Technology Service Management (ITSM) which in contrast to IT management (technology-oriented approach) is a process-oriented discipline (Wikipedia, 2014) that also shares common themes with the Process Improvement movement like Six sigma, CMMI or Business Process Management (Van Bon, 2002).

Taking up again the topic of large contribution of SMEs to the world economy, it is remarkable and comprehensible the continuously interest of SMEs about quality of their products which force them to find the way to strengthen their work. This is the point where the ITSM approach appears, proposing the attempt to establish canons of quality to ensure product performance and meeting customer expectations through the implementation of efficient software engineering practices. Software product needs to fulfill their mission satisfactorily (Energia e Industria, 2003).

This thesis aims to analyze how to strengthen Information Technology Service Management (ITSM) in SMEs by means of implementation of a set of software engineering practices adapted to their size and type of business.

1.2 Problem Description

Today more than ever, success of business and Technology Information (of the SMEs or not) is based on the capability to meet the needs of a set of increasingly demanding customers. Many standards have been emerged in the recent years; they are composed of a set of requirements that allows the enterprises maximizing capability to improve their services aside informality that usually characterizes most SMEs (Mishra & Mishra, 2009).

Generally, the need to maximize enterprise capabilities arises for achieving benefits as:

- International positioning and recognition of enterprises.
- Cataloging of software enterprise as competitive and suitable for export of software products.
- Consider business processes as mature.

These benefits are related to the implementation of any quality standard, norm or model. Nevertheless, achieving these benefits represent a big challenge for SMEs where the structure is considered small by definition (1 to 50 employees) and people are absorbed by pressing matters related to the tight deadlines that are generally attached to production tasks (Habra, Alexandre, Desharnais, Laporte, & Renault, 2008). But, the implementation issues of a standard/norm are not attributed only to SMEs characteristics; high cost and extensive definition of standards are evidence that they were not created to be implemented in this kind of enterprises. (Pino, García, & Mario, 2008)

A certification process can have an approachless scope for SMEs; implementation of all processes stated by selected standard/norm, even minimally, is a demanding process where technical and management resources are required (ITSM, 2008). However, this does not mean that SMEs cannot develop the needed capabilities to become a competitive and distinctive service provider even without owning a certification (Scalone, 2006). Well-establish good practices might be one way to seek for help. Activities or processes that have been successfully proved and used by multiple enterprises are considered as good practices, and an example of well-recognized set of best-practices for IT Service Management is Information Technology Infrastructure Library, also named as ITIL.

ITIL is used by many thousands of (all size) organizations around the world, the latest version structure of ITIL is based on service lifecycle which is described in a set of five core publications that contain good practices and 26 integrated processes for provision and service support with high quality (ITSM, 2008). Taking into account that ITIL is not a standard that certifies the accomplishment of practices and processes, it is not necessary that its 26 processes are fully implemented; the depth and demand

that the recommendations of ITIL are addressed depend on what the organizations consider appropriate according to: their current state, available staff and objectives in the short, mid and long term. (Figuerola, 2012)

Although ITIL helps the enterprises to not have to reinvent the way to manage their IT services, nevertheless it offers an adaptable system; ITIL does not prescribe how a service organization should be conformed or what processes/activities should be implemented, neither their implementation order; procedures and policies that should be developed are not described too (Figuerola, 2012).

The freedom to decide *what and how* the activities, processes or service lifecycle phases can be implemented in each organization in order to start introducing quality in their service management is one of the main reasons for adopting ITIL. This decision constitutes the first challenge that an organization must overcome when starting an ITIL implementation, where a solid and structured tactic needs to be conceived and strategically managed, being the enterprise size the leading factor to be considered in the decision making process.

At the end of this thesis, a proposal of a solid and structured tactic for ITIL implementation in SMEs will be presented, considering current problematic of the following ITIL processes (the name of the ITIL's processes are in brackets and bold):

- Regularly, those services that SMEs offer are implemented because they are a good idea or because they are an industry standard; instead of representing a good business case and demonstrating investment return (**Service Portfolio Management Process**).
- Lack of help to quantify IT value and contributions, and to quantify the business opportunities that IT services enable in SMEs (**Financial Management for IT Services Process**).
- SMEs do not analyze patterns in their business activity, hence they do not know the level of demand related to their services (**Demand Management Process**).
- Information about: deliverables, prices, contact points, ordering and request process of each IT service that enterprise offers are not structured (**Service Catalogue Management Process**).

- Lack of monitoring and improvement of customer satisfaction wit1h the quality of services delivered by the enterprise. In some cases, target of services quality is not defined (**Service Level Management Process**).
- Current and future availability needs of the business are not planned; also, targets of service availability are not defined, so as a consequence, IT services are not guaranteed for the customers (**Availability Management Process**).
- Lack of balance between costs and resources needed because resources can often be purchased or used without justification or efficiency (**Capacity Management Process**).
- Services do not provide the value that has been promised due to the lack of continuity of the service and the poor recovery plan of the enterprise (**IT Service Continuity Management Process**).
- Security risks in SMEs are not appropriately identified and managed. Levels of security in enterprises are not defined (**Information Security Management Process**).
- Contracts with suppliers are defined at the beginning of the process and they are not managed along the complete lifecycle. In some cases, enterprises do not have policies about selection and evaluation of suppliers (**Supplier Management Process**).
- Lack of appropriate response to different changes inside enterprises, for instance, stakeholders do not receive notification about changes on appropriate time (**Change Management Process**).
- Historical and current information about configuration of enterprise services is not available or it does not receive maintenance (**Service Asset and Configuration Management Process**).
- Knowledge transfer is not performed by customers and users at an adequate level in order to optimize the use of services (**Release and Deployment Management Process**).
- Sharing perspectives, ideas, experiences or information can be an inefficient activity if they are not available in the right place at the right time (**Knowledge Management Process**).
- Events of change might not have been notified causing problems with versioning in services documentation (**Event Management Process**).

- Incidents could not be monitored during their complete lifecycle preventing that the service is restored as soon as possible (**Incident Management Process**).
- Customer demands placed by users could not be attended because there are not handled according to their importance (**Request Fulfilment Process**)
- Problems caused by frequent incidents are not detected by using recurring incidents information (**Problem Management Process**)
- Frequently, capability to audit use of services and trace the abuse of them is not possible (**Access Management Process**)
- Lack of assessment of enterprises' current situation avoids to identify improvements opportunities inside them (**Continual Service Improvement: Seven-step improvement process**).

1.3 Importance of Resolution

Characteristics that allow enterprises to be denominated as small and medium can be changed according to countries. For example, the European Union defines SMEs as "*the enterprises which employ fewer than 250 persons and which have an annual turnover not exceeding 50 million euro, and/or an annual balance sheet total not exceeding 43 million euro"* (European Comission, 2005) [see Table 1.1] whereas that Andean Community of Nations (calls CAN because of its Spanish acronym) conformed by Ecuador, Bolivia and Colombia, defines SMEs as *"the enterprises which employ fewer than 200 persons which have total assets fewer four million dollars (close to 3 million euros) and which have an annual turnover not exceeding to five million dollars (close to 4 million euros)";* this information is provided by Super Intendencia de Compañias of Ecuador [see Table 1.2] who is based on the International Financial Reporting Standards (calls NIFF because their acronym in Spanish) (Super Intendencia de Compañias de Ecuador, 2001)*;* however, relevance and influence of this kind on enterprises in their respective economy is equivalent.

According to the General Business Directory (calls DIRCE due to its Spanish acronym), at 1st January 2013, there were 3,142,928 enterprises in Spain, and 99.88% are SMEs, that is 3,139,156 enterprises (Dirección General de Industria y de la Pequeña y Mediana Empresa, 2014).

Enterprise Category	Headcount: Annual Work Unit	Annual Turnover	or ↔	Annual Balance sheet total
Medium-Sized	< 250	≤ €50 million		≤ €43 million
Small	< 50	≤ €10 million		≤ €10 million
Micro	< 10	≤ €2 million		≤ €2 million

Table 1.1. SMEs European Union Categorization

Enterprise Category	Headcount: Annual Work Unit	Annual Turnover
Medium-Sized	< 200	≤ $ 5 million
Small	< 50	≤ $1 million
Micro	< 10	≤ $100 thousands

Table 1.2. SMEs Andean Community of Nations Categorization

In Ecuador, SMEs' situation is similar; at the end of 2012, the number of legal SMEs in Ecuador was 31,686, this number represents the 93% of active enterprises in this country (close to 34,000); these data are provided by Superintendecia de Compañías of Ecuador website [see Table 1.3]. This pattern is repeated around the world: in Italy, Japan and France, the number of SMEs accounted for 99% of the total number of enterprises; in the United States there are more than 15 million SMEs, accounting for 98% of the total number of enterprises; in Germany, SMEs-related exports value accounted for over 60% of the country total. Finally, in China SMEs accounted for 99.3% of total number of enterprises according to 2006 statistics (Garbarino-Alberti, 2013).

Enterprise Category	Number of Legal enterprises	%
Large-Sized	2.360	7%
Medium-Sized	4.889	14%
Small	10.277	30%
Micro	16.520	49%
Total Enterprises	34.046	100%
Total SMEs	31.686	93%

Table 1.3. Number of Legal SMEs in Ecuador (2012)

Noticeably, this large presence of SMEs in the economy leads to strengthen other areas; thus, SMEs contribution to the employment in both Spain and Ecuador is around 60% at 2013. Also, percentage of production participation of SMEs in these countries is about 50% (Dirección General de Industria y de la Pequeña y Mediana Empresa, 2014) (Superintendencia de Compañías of Ecuador website).

This information clearly shows why the SMEs are considered the back-bone of the world economy and also why the improvement of IT service management (ITSM) of these enterprises is an imperative issue to accomplish.

The growing incursion into several economic activities of Computer Services and Software Products (in house software products or outsourcing) leads the process of technological transformation in social and productive sectors of countries (República del Ecuador - Consejo Nacional de Planificación, 2013); hence, as it was mentioned, fortification of internal and external presence of this large number of SMEs through the improvement of their IT service management (ITSM) is a cornerstone for the improvement of the production core of the country just as it happened in the late 1980's when a serious economic downtown encouraged the UK's Central Computer and Telecommunication Agency to define a group of best practices which reduce their costs and improve the way to deliver their IT services (Sallé, 2004). These best practices seek to avoid the occurrence of problems in the delivery and operation of the services provided, in order to guarantee that their quality is perceived by clients and users (Magalhaes & Pinheiro, 2007). Thus, many models for maturity and management of IT service processes have been proposed, for instance: COBIT (ICASA, 2012), ISO/IEC 20000 (ISO/IEC, 2009) (ISO/IEC, 2010a) (ISO/IEC, 2010b) (ISO/IEC, 2011) (ISO/IEC, 2012), CMMI-SVC (SEI, 2010) and MR-MPS-SV (SOFTEX, 2012).

One of the most widely embraced ITSM initiative in private and public sectors around the world is the IT Infrastructure Library (ITIL). (Mohammad, Masarat, Azizah, & Shamsul, 2008) (Spremic, Zmirak, & Kraljevic, 2008). ITIL is a de-facto standard (a pattern or norm that has achieved a dominant position by public acceptance, that means that it is in practice but not necessarily prescribed by law) that has an iterative, multidimensional and lifecycle form structure whose implementation provides certification possibilities or at least ISO 20000 complies in IT service management processes. Also, there exists the possibility to perform self-assessment of enterprise's current practices using the checklist documents included in the ITIL official documentation.

Due to complexity of achieving a certification by SMEs, it is advisable that enterprises start their improvement process implementing the best practices recommended by

ITIL. ITIL provides a proven method for planning common processes, roles, and activities with appropriate reference to each other and how the communication lines should exist between them (Propoint Solutions, 2012). As mentioned previously, there exists evidence of widely use of ITIL: in US, 90% of 219 enterprises that use IT services, manifest that they are using any of ITIL processes (Winniford, Conger, & Erickson-Harris, 2009); in 2008, Axios Systems (Axios Systems, 2008) informed that 64% of IT professionals believe that following ITIL recommendations are a key for improving reputation of Information Technology.

In this way, implementation of ITIL practices acquires considerable importance as well as other benefits like: increasing user and customer satisfaction with IT services; financial savings due to less rework and less time used, and improved resource management and usage; improved decision making and optimized risk; and better alignment based on the business focus (Diirr & Santos, 2014).

Described benefits maximize the relevance to find a solid and structured tactic for the ITIL implementation in SMEs.

1.4 Goals of Thesis

Once the problematic and importance of resolution of this master thesis have been defined related to the specific context, goals are presented in two sections: purpose and research questions, and research goals, objectives and scope.

1.4.1 Purpose and research questions of this thesis

The purpose of this thesis is to contribute to the implementation of ITIL framework in SMEs by proposing a novel solution to:

I. Ensure an ITIL implementation proposal that: a) takes into consideration SMEs constrains; b) represents, in a consistent way, these constrains; c) keeps an original freedom and flexibility that characterize ITIL; and d) can be used among various SMEs.
II. Implement at least one ITIL process in a SME according to a process activities organization represented by profiles.

To achieve this research purpose, the following research question has been formulated: How can an ITIL implementation proposal be represented to better suit the constraints of SMEs? This research question is subdivided into the following sub-questions:

i. What are the constraints of SMEs when they are conducting any process standard/framework/norm initiative?
ii. How well current process models for services in a SMEs environment work?
iii. Is it possible to implement a sequence of three ITIL processes in a SME environment?
iv. What would be the first ITIL process in an implementation sequence to be implemented in a SME?
v. What would be the procedure for implementing the first ITIL process in the proposed implementation sequence in a SME?

1.4.2 Research Goals, objectives and scope

The research goal of this thesis is to contribute to the creation of a proposal for implementing ITIL in SMEs environment. More specifically, this thesis aims at helping services provider enterprises and their employees to know how to carry out best practices for improving their services.

Two research objectives are defined in this thesis: 1) proposing an implementation sequence of ITIL processes in SMEs; 2) defining a strategy for implementing the first ITIL process of the found sequence obtained in the previous research objective.

A measure of success of this proposal will be that it should not be complicated to carry out the activities described in the process and it must allow the active participation of employees and the interest of managers to introduce a best-practice framework.

For achieving this objective, the following research sub objectives are defined:

- To determine the best services process model for implementing best-practices in SMEs distinguishing the weaknesses of these models in this context.
- To perform a systematic review in order to know current scientific evidence about ITIL implementation purposes in SMEs described in valuable case studies.

- To know the recommendations of IT professionals and process models experts about ITIL implementation in SMEs.
- To identify the relevant reasons why the enterprises decide/want to start an ITIL implementation.
- To determine an ITIL implementation sequence based on the previous findings.
- To identify the appropriate way to carry out an implementation of the first ITIL process in the implementation sequence that has been obtained.
- To perform a case study using the proposed implementation strategy.

The scope of this research is limited by a) the size of the enterprise used to implement the strategy; b) the number of processes to conform the implementation strategy.

1.5 Thesis Structure

This master thesis is structured in 6 chapters.

This chapter, titled INTRODUCTION, is chapter one. This presents the context where the master thesis is developed. A problem to resolve is described in order to know current weakness related to the master thesis's context. Importance of resolution is also described in chapter one. Finally, master thesis goals are presented in terms of: purpose, research questions, research goals, objectives and scope.

Chapter 2 entitled STATE OF ART, presents a review focus on existing process models and systematic review process where the interest points are: 1) what has already been published that attempts to solve the research sub-questions formulated in chapter 1; 2) accepted academic techniques and approaches that could contribute to solving our research sub-questions; 3) issues that have not been solved by the academia, the industry or other research efforts.

Chapter 3 entitled RESEARCH METHODOLY, ACTIVITIES AND EXPECTED RESULTS, presents the research methodology used to address the research sub-questions. It first introduces the purposes of the research and the design of a proposal to address them; next, it follows with the description of the research plan and the research operation phase which includes an explanation of the research activities and their execution; and it concludes with the interpretation phase of the results obtained

from the execution of the research activities. Chapter 3 also describes the design of case study and two surveys.

Chapter 4 entitled BUILDING THE IMPLEMENTATION STRATEGY presents the development process of the novel ITIL implementation strategy for SMEs proposed as research goal of this thesis. It is drawn upon the results of the research methodology – phase one (Chapter 3). Also, a detailed description of the ITIL process to implement using the strategy is described.

Chapter 5 entitled CASE STUDY, presents the application of the implementation strategy (Chapter 4) in one Ecuadorian SME. A survey about SME status before implementation and after implementation is analyzed too.

Finally, the conclusions chapter (Chapter 6) of the thesis summarizes the main contributions of this research. We revisit the research sub-questions that have been formulated, and how they have been addressed. We present also the expected impacts of this research work, and analyze its limitations. Finally, some recommendations for future research work are proposed. These recommendations aim to motivate for performing new research or implementation strategy in order to build up contributions to the knowledge generated in this research.

CHAPTER 2

STATE OF ART

In this chapter, review of related work about the research purpose is presented. In order to attempts to resolve research sub-questions defined in chapter one, the most important existing Process Models will be presented. Comparison between described Process Models is performed through Evaluation Criteria definition. After, a process of gathering and evaluation will be performed which will provide available evidence pertaining to the implementation sequence of ITIL processes that SMEs use. For this purpose, Systematic Review (SR) methodology will be used, including a comparative analysis by using evaluation criteria. At the end of the chapter, final conclusions according to the evaluation criteria will be written emphasizing existing gaps about interest field of this study.

2.1 Process Models

In literature it is possible to find multiple definitions or conceptions of the terminology related to this research (e.g., process, process models, process models for services, etc.) Therefore, before proposing any solution or strategy, it is necessary to review and put in context this term. Also, it is a valuable approach to know the existing context about process models in order to establish a starting point to this research. Following sections present these two important topics.

2.1.1 What is a Process?

As mentioned in chapter one, TI was no longer limited by the computational capability or hardware operations; the need to involve persons and technology in a common pursuit of objectives is a broad-ranging task that needs to rely on a solid organizational development (McLean, 2009). Organizational analysis is a way to start an organizational development in enterprises. During this analysis, a set of positive and negative experiences which were occurred in all areas of the enterprise and working life of employees is obtained; the goal is to find ways to build on the positives and to overcome the negatives (using artifacts, norms, behaviors) for finally cooperate systematically with enterprise business (Garvin, 1998).

It is right to think that all enterprises try to know how to face negative experiences; however, repeat organizational analysis each time the enterprise requires an adjust of their operations, cannot be a good practice. The difficulty to get the things done is a problem which scholars faced who are trying to describe organizational functioning in other than static, highly aggregated terms. Processes provide a likely solution (Chakravarthy & Doz, 1992).

A process is a particular method of doing something, generally involving a sequence of steps associated with a set of activities which are performed in accordance with ordering constraints until the desired results are obtained. A Software Process is a process defined to develop software, if this process is running inside enterprises together others processes like business processes, training processes, architecture process; the Production of Software (or another final product) will accomplish desired enterprise objectives and also shares the best practices and lessons learned across the organization (Antonio, 1998). Particularly, when a Software Process is represented in an abstract way and it is described from a particular perspective, it is denominated Software Process Model.

Any process needs to define a description. A process description shall take into account any relevant national, international or organization-specific product and process standards. In addition, a style guide should ensure a uniform terminology for all process descriptions. Other elements that may be include in a Process Description are the following: participating roles, initial and end criteria, initial and end products, decision gates, products to be submitted to quality control measures, process interfaces, etc. (Hoch, et al., 2006).

Once the operational definition of the basic processes in the enterprise is performed, they are called Standard Processes. A standard process describes the fundamental elements that guide the establishment of a common process across the projects in an enterprise. A standard allows to employ and enforce mandatory requirements that give a uniform approach for any project implementation in enterprises (Paulk, Weber, Garcia, Chrissis, & Bush, 1993).

The Software Life Cycle Models are the more classic software process models which were appeared since 1960´s (Hosier, 1961) (Royce, 1987) (Distaso, 1980) (Scacchi,

1984) (Somerville, 1999); nevertheless, explicit models of software evolution date back to the earliest projects developing large software systems in the 1950´s and 1960´s (Hosier, 1961). Different Software Life Cycle Models exist and are used in spite of many of them are minor variations on a small number of basic models (Somerville, 1999). The Common factor between these models is simple: provide a conceptual scheme for rationally managing the development of software systems (Scacchi W. , 2001).

In the 80s, early efforts in monitoring and measuring software process performance in industrial practice are appeared (Humphrey, 1985) (Radice, Roth, O'Hara, & Ciarfella, 1985) (Basili & Rombach, 1988). The intended was that in the context of a software development project, the traditional software development models have to be compatible with provision of software quality assurance, configuration management, and verification and validation services (Scacchi W. , 1984). Thus, it has resulted that different institutions have developed countless models (CMMI, ISO), which try to assure that approaches involved in software development process are being carried out with the goal of producing software according to the client expectations and effective use related to enterprise resources.

As customer expectations has increased, enterprises started to take note that it was not enough that the final product is developed using a tailored software life cycle process model or a quality model; additionally, software aspects outside developing product area should also be structured. Thus, processes models (or standards) for stablishing, managing and delivering one or more services that meet or exceed customer needs begin to be created (Software Engineering Institute, 2009). Improving service delivery practices of enterprises becomes a way to improve customer satisfaction, performance and profitability of organizations that provide any kind of services.

In the next section the most used Process Models for Services are presented.

2.1.1 Process Models for Services

The need to provide a service operation aligned with the business requirements has become a requirement within enterprises. In this section, a variety of process models for services with different beginning and structures are presented. The objective is to

know how the process models operate considering if their structures prescribe "what" and "how" the defined activities by them could be implemented in SMEs environment.

2.1.1.1 CMMI-SVC

Capability Maturity Model Integration - CMMI is an evolution of the initial standard Capability Maturity Model (CMM) developed in 1986 by the Software Engineering Institute – SEI of Carnegie Mellon University. This standard was developed at the request of the United States Department of Defense that had the need to control the software development capabilities of its contractors. Best practices described in a CMMI standard are grouped into three interest areas denominated constellations: 1) CMMI- DEV contents best practices for products and services development, 2) CMMI-ACQ contents best practices for products and services acquisitions, and 3) CMMI-SVC contents best practices for service establishment, management and provision.

The Capability Maturity Model Integration for Services (CMMI-SVC) best practices focus on activities for providing quality services to the customer and end users. CMMI-SVC integrates bodies of knowledge that are essential for a service provider. It was designed to improve mature service practices and contribute to the performance, customer satisfaction, and profitability of the economic community (Forrester, Buteau, & Shrum, 2009).

CMMI-SVC provides two ways of representation (and assessment): it can represent the whole organization (staged) or each process (continuous). There are 24 processes that are characterized by specific goals and specific practices; however there are some generic goals and generic practices used for all the processes. The continuous representation is concerned with selecting both a particular process area to improve, and the desired capability level for that process area. The staged representation is concerned with the overall maturity of the organization, whether individual processes are performed or incomplete is not the primary focus (Forrester, Buteau, & Shrum, 2009).

The structure of this maturity model is considered a little closed because the levels defined in both representations determinate the processes that should be implemented. So, sequence processes implementation is not decided according the enterprise needs

and/or capabilities or particular characteristics. CMMI-SVC structure does not consider the enterprise size as a factor to define their levels, hence it will be hard to SMEs completing it.

2.1.1.2 Operations Management Capabilities Model

It was defined by Sun Microsystems in 2009, the Operation Management Capabilities Model (OMCM) (Sun Microsystems, 2009) provides a framework and measurement guidelines for improving the IT management which helps to define, measure, and assess the current enterprise capability and the capability required to achieve in the future. As in others models, best practices for IT management are defined and distributed in different processes that are grouped into six categories. Four categories (IT Services Creation, IT Services Implementation, IT Services Provision, and IT Services Improve) are conformed by independent processes whereas IT Service Control category requires the existence of processes of previously categories. Finally the IT Services Protection category acts as supervisor in order to ensure the availability of all processes regardless of their category (Sun Microsystems, 2009).

One advantage of the described structure is the design of the categories. Due to the design, categories can easily relate to other IT Services Models. So, most process activities are performed around one category but in some ways, these can also be related to another different category (Sun Microsystems, 2009).

2.1.1.3 COBIT

Control OBjectives for Information and related Technology (COBIT) is a comprehensive framework that assists enterprises to achieve their goals and deliver value through effective governance and management over enterprise IT (ISACA, 2012). Created and maintained by ISACA -Information Systems Audit and Control Association- and The IT GI (Information Technology Governance Institute), COBIT has had five versions, the last version appeared in 2012 and it is focused on helping enterprises to create optimal value from IT by maintaining a balance between realizing benefits, optimizing risks levels and resources use. For this purpose, five key principals are defined:

1) Meeting stakeholders needs.
2) Covering the enterprise end-to-end.

3) Applying a single integrated framework.
4) Enabling a holistic approach.
5) Separating governance from management.

The first principle is aligned to a government goal: obtain benefits through optimizing resources costs and risks; in other words, create business value. Integration between business government and IT management in the corporation is the scope of the second principle, this is possible because the defined processes handled the technology and information as part of enterprise assets instead of handled it as an isolate part of "IT functions". A difference of other standards that focus on the processes grouped by IT activities, COBIT aligns its definition on a top level becoming the principal framework for the government enterprises that in association with the IT management are considered a single integrated framework as refers third principal.

Fourth principle refers to a holistic approach that is achieved due to the use of different catalysts as: principles, policies and frameworks, organizational structures, services, infrastructure and application, people, skills and competencies. The holistic approach for governing and managing IT on all enterprise transforms COBIT in a generic and useful framework for enterprises of all sizes: commercial and non-profit or public sector. Finally, the clearly distinction between government and management in COBIT leads to define different activities, organizational structures and others catalysts in order to achieve purposes according to this two disciplines such as the fifth principle refers.

The union of these principals qualifies the enterprise for building a government management framework where the effective management optimized the inversion and the use of information & technology for the benefit of the interested parts (ISACA, 2012).

As it is known, each enterprise is a unique environment and operates in a different context, this context is determinates by external factors (industry, market, politics) and internal factors (culture, organization, risks, enterprise size) which require a customize government and management system. This idea can be structured using a COBIT 5 cascade goals mechanism, so that is the definition of 17 generic goals and 17 generic IT Goals. This means that the artifacts that the enterprise needs to implement in order

to achieve selected goals need to be selected (or created in some cases) by the enterprise. COBIT 5 framework does not suggest an implementation sequence according to the any enterprise factor, as a size.

2.1.1.4 eSourcing Capability Model for Service Providers (eSCM-SP)

This model was created by The Center for IT Services Qualification of Carnegie Mellon University.

In a general view, eSCM is twofold: eSCM-CL for Clients and eSCM-SP for Service Providers. These two models are consistent, symmetrical and complementary for each side of the client-provider relationship and this is the strength and the uniqueness of this model (ITSqc, 2014).

This model has three purposes: (1) to give service providers guidance that will help them to improve their capability across the sourcing life-cycle, (2) to provide clients with an objective means of evaluating the capability of service providers, and (3) to offer service providers a standard to use when differentiating themselves from competitors. Formed by 84 practices, the model is focused on the three dimensions: the life of the contract, the area of capacity, and the capability level which are represented in the Figure 2.1 (ITSQC, 2014). For each of these dimensions, a list of activities and clarifying information are provided. Practices address the critical capabilities for eSourcing Service providers that are associated with successful sourcing relationships. Most practices refer to establishing a policy, procedure, guide, program or plan.

Although most quality models focus only on delivery capabilities, in eSourcing there are also critical issues associated with initiation and completion of an engagement, as well as the overall capabilities of the service provider.

For this reason, the first dimension of the eSCM-SP is the Sourcing Life-cycle which is divided into four practices: Initiation, Ongoing, Delivery, and Completion. Ongoing practices span the entire Sourcing Life-cycle, while Initiation, Delivery, and Completion occur in specific phases of that lifecycle (ITSQC, 2014).

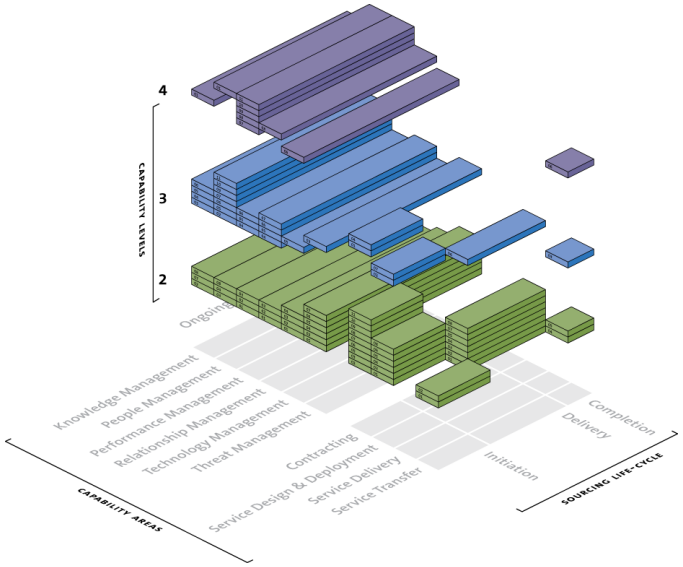


Figure 2.1: eSourcing Capability Model for Service Providers Structure (ITSQC, 2014) (ITSqc, 2014).

The Capability Areas provide logical groupings of Practices to help users to intellectually manage the content of the Model. Service providers can then build or demonstrate capabilities in a particular critical-sourcing function. The ten Capability Areas are Knowledge Management, People Management, Performance Management, Relationship Management, Technology Management, Threat Management, Service Transfer, Contracting, Service Design & Deployment, and Service Delivery (ITSQC, 2014).

The five eSCM-SP Capability Levels indicate the level of an organization's capability. Level 1 indicates that the organization is providing a service. A Level 2 organization has procedures in place to enable it to consistently meet its clients' requirements. At Level 3, an organization is able to manage its performance consistently across engagements. Level 4 requires that an organization is able to add value to its services through innovation. Service providers at Level 5 have proven that they can sustain excellence over a period of at least two years (ITSQC, 2014).

Surely, this model is useful when the integration between client and service provider is complex. However, it would be difficult if eSCM-SP is not complemented with another framework specialized in a global service management approach. eSCM-SP adjusts very well if Service Management is done in an Outsourced setting.

2.1.1.5 Reference Model for Improvement in Service Processes

The Reference Model for Improvement in Service Processes or MR-MPS-SV, its acronym is derived from "Modelo de Referência de Melhoria de Processos de Serviços" in Portuguese is a Brazilian maturity model for IT service provider companies which was created as part of the MPS.BR Program. The MR-MPS-SV focuses on microenterprises and small to medium-sized companies, and presents seven maturity levels, progressing from G to A, where:

- (G) Partially managed, (F) managed, (E) partially defined, (D) widely defined, (C) defined, (B) quantitatively managed, and (A) optimizing.

The division into seven levels enables the implementation and adequate assessment of microenterprises and small to medium-sized companies. Also, it can increase the visibility of the process improvement results in a shorter amount of time (Diir & Santos, 2014)

The advantage of this model is focused on its definition because it is concretely focused on SMEs. The way in which the maturity levels are defined can give an idea of an implementation sequence of the model, the company implements processes based on the maturity level that it needs to achieve.

2.1.1.6 Microsoft Operation Framework (MOF)

Microsoft® Operations Framework (MOF) consists of integrated best practices, principles, and activities that provide comprehensive guidelines for achieving reliability for IT solutions and services. MOF provides question-based guidance that allows you to determine what is needed for your organization now, as well as activities that will keep the IT organization running efficiently and effectively in the future (Microsoft Corporation, 2008).

The goal of MOF is to provide guidance to IT organizations to help them create, operate, and support IT services while ensuring that the investment in IT delivers expected business value at an acceptable level of risk. MOF promotes a logical approach to decision-making and communication and to the planning, deployment, and support of IT services. MOF's purpose is to create an environment where business and IT can work together toward operational maturity, using a proactive model that defines processes and standard procedures to gain efficiency and effectiveness. The IT

service lifecycle is composed of three ongoing phases, and one foundational layer that operates throughout all of the other phases. The phases and the layer are: Plan Phase, Deliver Phase, Operate Phase and Manage Layer.

The Plan Phase is generally the preliminary phase. The goal of this phase is to plan and optimize an IT service strategy in order to support business goals and objectives. The Deliver Phase comes next. The goal of this phase is to ensure that IT services are developed effectively, are deployed successfully, and are ready for Operations. Next, it is the Operate Phase. The goal of this phase is to ensure that IT services are operated, maintained, and supported in a way that meets business needs and expectations. The Manage Layer is the foundation of the IT service lifecycle. Its goal is to provide operating principles and best practices to ensure that the investment in IT delivers expected business value at an acceptable level of risk. This phase is concerned with IT governance, risk, compliance, roles and responsibilities, change and configuration management. Processes in this phase take place during all phases of the lifecycle.

Each phase of the IT service lifecycle contains service management functions (SMFs)

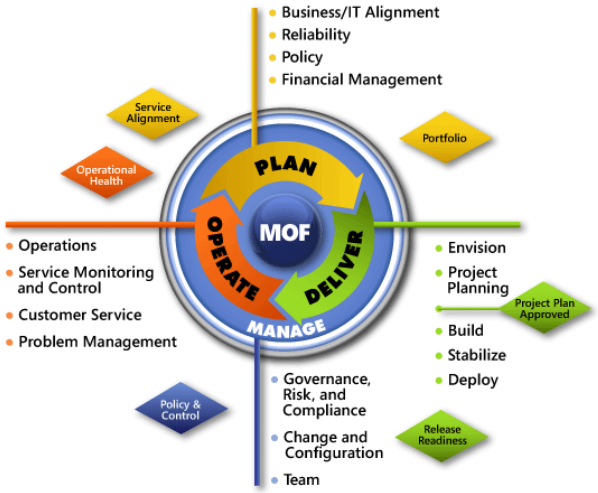


Figure 2.2: Microsoft Operation Framework Structure (Microsoft Corporation, 2008)

that define the processes, people, and activities required to align IT services to the requirements of the business. Each SMF has its own guide that explains the flow of the SMF and details the processes and activities within it. Figure 2.2 shows the IT service lifecycle phases and the SMFs within each phase (Microsoft Corporation, 2008).

Despite of MOF prescribes phases in a life cycle sequence, the processes which are described inside them do not have determinate an implementation sequence. This situation does not allow enterprises to know the starting point according their size.

2.1.1.7 Information Technology Infrastructure Library - ITIL

There exist a concept which in the modern world is compelling. This concept is focusing on the idea of having a strategy to drive the business forward with the adequate planning and design transitioning into day-to-day operation. In 1980s a lot of experts had the need to explore more in deep the concept of IT Service Management. Principal initiative was started by UK government; its result was Information Technology Infrastructure Library (ITIL). ITIL provides guidance to services providers on the provision of quality IT services, and on the processes, functions and other capabilities needed to support them. It is globally recognized as the best practice framework for service management. The universal appeals of ITIL is that it continues to provide a set of processes and procedures that are efficient, reliable and adaptable to organizations of all sizes, enabling them to improve their own service provision (Best Management Practice, 2011).

Many hundreds of organizations around the world are offering services with more quality since they are implementing best practices described in ITIL publications. ITIL is not a standard that has to be followed, on the contrary, ITIL publications should be read and understood, and used to create value for the services providers and its customers; this is possible by adapting the practices to the specific environments of providers in ways that meet their needs.

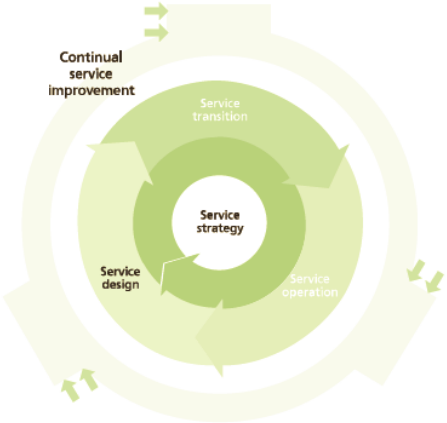


Figure 2.3: Information Technology Infrastructure Library Structure (OGC, 2011)

The standard to be achieved and maintained through ITIL is ISO/IEC 20000; the useful body of knowledge for achieving the standard is described on the five stages of ITIL service life cycle which uses a hub-and-spoke design Figure 2.3, that is: Service Strategy at the hub, Service Design, Service Transition and Service Operation as the revolving lifecycle stages or "spokes", Continual service improvement surrounds and supports all stages of the service lifecycle. Each stage exerts influence on the others and relies on them for inputs and feedback (Best Management Practice, 2011). Throughout the service lifecycle, checks and balances ensure that as business demand changes with business need, the services can adapt and respond effectively.

Each stage of ITIL lifecycle is described in individual publications, which address capabilities having direct impact on a service performance of providers. *ITIL Service Strategy* is the first publication, and it provides guidance on how to view service management, not only as organizational capability but as a strategic asset. Development market spaces, characteristics of providers' types (internal and externals), services assets, service portfolio, business relationship management, demand management, financial management, organizational development and strategic risk are the major topics covered in this publication which are useful for developing service management policies, guidelines and processes across the ITIL Service Lifecycle. Service Strategy is about ensuring that organizations are in a position to handle the costs and risks associated with their service portfolios; in general words, the organizations need to stop and think about why something is to be done before thinking of how.

ITIL Service Design publication provides the guidance for providing true value to the business. It means the service must be designed with the business objectives in mind in order to turn a service strategy into a plan for delivering the business objectives. This is possible because topics like design coordination, service catalogue management, service level management, availability management, capacity management, IT service continuity management, information security management, and supplier management describe the improvements that are necessary to increase or maintain the value to customers over the lifecycle of service.

ITIL Service Transition describes the key concepts for the development and improvement of capabilities introducing new and changed services into a specific environment, controlling risk and supporting organizational knowledge for decision support. Effective transition is possible due to the value identified in the service strategy, and encoded in the service design that can be realized in service operation. The service knowledge management system is a key topic introduced in this stage; this system supports organizational learning which will allow people to benefit from the knowledge and experience of others improving the overall efficiency and effectiveness of all stages of the service lifecycle.

Best practices for managing services in supported environments is described in the *ITIL Service Operation*. Detailed process guidelines, methods and tools for maintaining stability in service operation are provided in two perspectives: reactive and proactive; reactive, thorough avoiding or resolving services incidents or managing problems; and proactive, through managing availability, controlling demand, or optimizing capacity. Service operation guide to managers in order to achieve efficiency and effectiveness in the delivery and support of services.

Finally, the *ITIL continual Service Improvement* publication describes the best practices for achieving incremental and large-scale improvements in service quality, operational efficiency and business continuity; ensuring that the service portfolio continues to be aligned to business needs (Best Management Practice, 2011). This is possible thanks to a closed loop feedback system based on the Plan-Do-Check-Act cycle.

After knowing more about ITIL lifecycle, it is possible to ensure that ITIL embraces a practical approach to Service Management based on a single aim: delivering value to the business.

2.1.2 Final considerations related to Process Models

As mentioned previously, process models describe conceptually "what" it is important to do in order to establish, manage and deliver services which meet or exceed customer needs. In some cases implementation order is established by levels. This implementation way means that is mandatory to implement a level completely in order to access to the next level. This situation is really hard to achieve by SMEs.

The following list (Table 2.1) refers to four evaluation criteria which are used to know what is the process model that best could be adapted in order to help to small and medium enterprises to improve their customer satisfaction, performance and profitability.

Evaluation Criteria for Process Models
V: Is the Process Model a Framework?
W: Is the Process Model open structured?
X: Is the Process Model SMEs-oriented?
Y: Does the Process model describe the type of organization the enterprise should have?
Z: Is the process model execution affected when an implementation sequence change according to enterprise size?

Table 2.1: Criteria to compare Process Models

Evaluation results are showed in Table 2.2. ITIL is the framework more adaptable which offers to services providers the freedom to decide "how" and "why" activities / processes / life cycle stages can be implemented; this is one of the main reasons for adopting ITIL, because this decision is the first challenge that an enterprise must faces when making improvements in its business.

Process Model	V	W	X	Y	Z
CMMI-SVC	○	○	○	○	○
Operations Management Capabilities Model	●	◑	○	○	○
COBIT	●	◑	○	○	○
eSourcing Capability Model for Service Providers (eSCM-SP)	●	○	○	○	○
Reference Model for Improvement in Service Processes	○	○	●	●	○
Microsoft Operation Framework (MOF)	●	○	○	○	○
ITIL	●	●	◑	○	●

Legend: ● Yes, ○ No, ◑ Not explicitly specified.

Table 2.2: Comparison between Process Models

2.2 Systematic Review

2.2.1 Systematic Review Background and Definition

A way to compare and combine results from different studies is using meta-analysis. In spite of, at twelfth century in China an instance of use of this research methodology was presented by a very famous philosopher who built up a philosophical theory (Hsi, 1130~1200) and in seventeenth century astronomy studies were performed using meta-analysis. In 1976 the meta-analysis term were formalized by Gene V. Glass who defined it as "*analysis of analysis"* where *"a statistical analysis of large collection of analysis results from individual studies for the purpose of integrating the findings"*

(Glass, 1976). Meta-analysis is often, but not always, an important component of a Systematic Review procedure.

Systematic Review (SR) or also called Systematic Literature Review is a specific methodology of research which is developed in a formal and systematic way by a strict sequence of methodological steps according to an aprioristically developed protocol. Creating generalizations through of empirical research integration is the principal reason because the systematic review goes one step further than the simple usual process of literature review. As it is frequent, adequate definition of specific objectives represent the key factor that allows the researchers to critically analyse and resolve conflicts in the literature material in order to identify issues that can change the course of current or future investigations (Biolchini, Gomes, Cruz, & Horta, 2005).

Systematic Review is widely used in medical field. A study conducted by Budgen, who used the evidence-based paradigm, determined that the Social Science research practices (includes medicine field) are more much similar to software engineering research practices (Budgen, y otros, 2006); however, it is well-known that within experimentation in software engineering is hard to handled completely factors (like human expertise or randomized controlled trial) that could affect experiment outcome; this situation was not presented in medical experiments which mean that despite of Budgen study results, software engineering is not much similar to this field, where the first systematic review was developed (Software Engineering Group Keele University; Department of Computer Science University of Durham, 2007). Nonetheless Budgen's study was not the only that tried to use the analogy with medical practice for defining a way to perform systematic reviews in software engineering field. So, Kitchenham evolved the idea of evidence-based software engineering and she drawn up the first proposal for how to **conduct** a systematic review focused on Software Engineering research (Biolchini, Gomes, Cruz, & Horta, 2005).

2.2.2 SR Process

Biolchini et al. (Biolchini, Gomes, Cruz, & Horta, 2005) propose another alternative to the Systematic Review process. This proposal is defined in a general way (aplicable to all study fields different to Software Engeneering) as a sequence of three phases: (1) Concepts, (2) Studies, and (3) Results; however, there exists more specific and operating SR process which is defined using the following five steps: (1) Problem

Formulation, (2) Data Collection, (3) Data Evaluation, (4) Analysis and Interpretation, and (5) Conclusion and Presentation. So, in general, systematic reviews conduction can be grouping into three-steps approach: (1) Plannig, (2) Execution, and (3) Result Analysis; but the possibility to appear the control activities during this three-step approach is not discarted. . Following Figure 2.4 shows principal steps and posible control activities (internal steps or iterative activities) of the SR process.

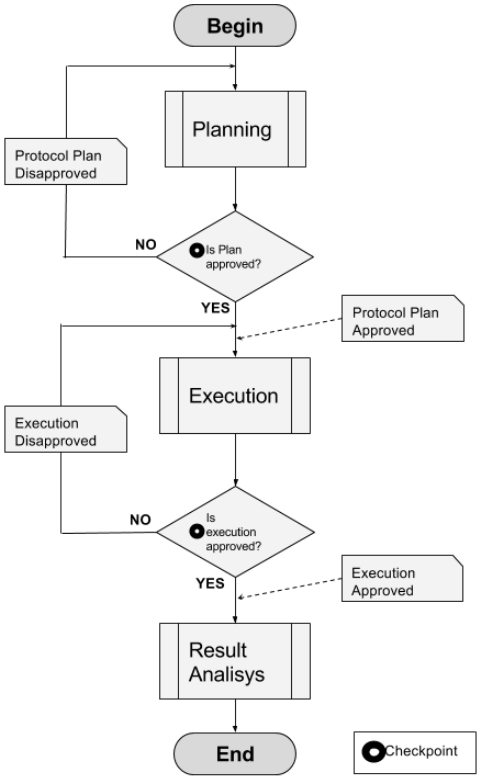


Figure 2.4: Systematic Review Process (Biolchini, Gomes, Cruz, & Horta, 2005)

During the Planning step, the research objectives and reviewed protocol are defined. In the Execution step, primary studies need to be identified, selected and evaluated according to the parameters (inclusion and exclusion criteria) defined in the previous step; only the selected primary studies are used in the Result Analysis step where the data of these studies are extracted and synthesized. These steps can be executed many times, as research considers appropriate. All information obtained during the whole process performance is called SR packing. Also, in Figure 2.4, it can be observed that two checkpoints have been considered. In the first checkpoint, the viability of planning needs to be guarantee; if this condition does not met, the Execution step does not begins and the researcher must return to the Planning step. Similarly it occurs with the

second checkpoint, if sources of primary studies have problems, the Execution step needs to be repeated.

So, conducting a SR is not a simple task. The process steps should be documented, including possible intermediary results. So, in order to facilitate and lead to software engineering researchers through each step of SR process mentioned previously, a Review Protocol Template has been developed where each template section need to be clearly defined with information appropriate to the SR process steps that it belongs (Biolchini, Gomes, Cruz, & Horta, 2005).

Also, in the annex 1, detailed description of Systematic Review Protocol Template has been explained.

2.2.3 SR Protocol Template Deployment

In this section, the template development for performing a SR is presented: ITIL process implementation sequence in Small and Medium enterprises.

1. Question Formularization

   The systematic review objective should be clearly established in order to formalize the question.

   1.1. Question Focus

   Systematic Review is carried out to identify and analyse initiatives presented in scientific publications or experience reports on Sequence of ITIL process implementation in enterprises of all size.

   1.2. Question Quality and amplitude

   In this section, some items are specified in order to define the context in which the SR is applied and the question the study must be answered. Items are:

   - *Problem:* ITIL V3 framework is a set of comprehensive publications providing descriptive guidance on the management of IT processes, functions, roles and responsibilities related to Information Technology Service Management (ITSM). This guidance is integrated by 26 processes. However, ITIL V3 framework does not prescribe what processes / activities should be implemented neither their implementation order, specifically in Small and Medium enterprises.

- *Question (RQ: Research Question):*
  - RQ1: What are the constraints of SMEs when conducting ITIL implementation activity?
  - RQ2: How well do current process models for services in a SMEs environment?
  - RQ3: Is it possible to implement a sequence of three ITIL processes in a SME environment?
  - RQ4: What would be the first ITIL process in an implementation sequence to be carried out in a SME?
  - RQ5: What are the most suggested/used criteria for determining an implementation sequence of ITIL V3 processes in SMEs?
- *Intervention:* Implementation sequence of ITIL V3 processes.
- *Control:* Initial Data is not presented
- *Effect:*

  - ITIL V3 process suggested/used as an implementation sequence in enterprises of all size.

  - Criteria used to define the implementation sequence of ITIL V3 processes.
- *Outcome Measure:*

  - Number of times that an ITIL V3 process is identified as the first, second or third item of suggested/used implementation sequence of ITIL processes.

  - Criteria identified in the implementation sequence of ITIL processes.
- *Population:* Scientific publications or experience reports related to ITIL process implementation in all size enterprises, which have been published.
- *Application:* organizations and researchers that have investigated about initiatives of Sequences of ITIL processes implementation and their selection criteria.
- *Experimental Design:* None experimental design will be performed.

2. Sources Selection

The objective of this section is to select the sources where the primary studies will be executed (Biolchini, Gomes, Cruz, & Horta, 2005).

2.1. Sources Selection Criteria Definition

The source selection criteria are:

- Databases that include journals, papers focused on software engineering empirical studies, human factors in software engineering and software quality.
- Databases with mechanisms of advanced search to take into account the terms and synonyms used in the search questions.
- Availability of the complete text papers.
- Specialized journals available in the library of the Universidad Politécnica de Madrid (UPM).

2.2. Studies Languages

Studies are written in English and/or Spanish.

2.3. Sources Identification

The identification of sources has been based on the criterion of experts in our research area.

- *Source Search Methods:* Following journals are include as source: European Journal of Operational Research, Information and Software Technology, Software: Practice and Experience, Software Process: Improvement and Practice, IEEE Software, Software Technology and Engineering Practice, Computer and research workshops & technical reports of Software Engineering Institute – SEI, among others.
- *Search String:* Keywords from the word set defined in the question were extracted. Combining these keywords with the logical operators "AND" and "OR", five search strings were obtained. These search strings have been adapted for each web browser of the sources. Table 2.3 shows the obtained search strings.

	Search String
1	(case study or lesson learned or adoption or exploratory study) and (('implementation' or implementing) and (ITIL or IT framework or IT infrastructure library))
2	"ITIL V3" and "implementation"
3	"ITIL" and "implementation"
4	"implementing" and "ITIL V3"
5	"implementing" and "ITIL"

Table 2.3: Systematic Review - Search strings

- *Sources List:* this is a general list of sources related to computer science and software engineering field:
  - Academy of Management Journal and Review.
  - Administrative Science Quarterly.
  - ACM Portal.
  - California Management Review.
  - Harvard Business Review.
  - IEEEXplore.
  - ISI Web of Knowledge.
  - Management Science.
  - MIT Sloan Management Review.
  - Organization Science.
  - Science Direct.
  - Scopus.
  - SpringerLink.
  - Strategic Management Journal.

  Also, Google search engine can be used in order to retrieve publications not indexed by previously sources as well as grey literature (master thesis documentation or studies not published).

2.4. Sources Selection after Evaluation

Considering criteria defined to select sources in section 2.1, the final list of sources is presented in Table 2.4.

#	Source
1	ACM Digital Library
2	IEEE Computer Science Digital Library
3	Springer Link
4	Science@Direct
5	Software Engineering Institute
6	ISI – Web of Knowledge
7	GOOGLE

Table 2.4: Systematic Review - Source list.

3. Studies Selection

In this systematic review an iterative and incremental procedure is used for studies selection: a) Iterative, to group all activities that could be repeated during the procedure, and b) Incremental, because the studies are approached and recorded one by one until obtaining the systematic review results. This iterative and incremental procedure is used due to its functionality in other systematic reviews. This section describes the process and criteria for studies selection and evaluation.

3.1. Studies Definition

- *Studies inclusion and exclusion criteria definition:* due to the search executed in web engines, a great number of articles that do not answer research questions may be found (Biolchini, Gomes, Cruz, & Horta, 2005), and it is necessary to define inclusion criteria (IC) and exclusion criteria (EC) which make an article a potential candidate to be selected or to be excluded to the review. Criteria definitions are shown in Table 2.5.

Acronym	Criteria Description
IC1	Include papers whose title is related to ITIL V3 implementation.
IC2	Include papers that contain keywords that match with those defined in the search string.
IC3	Include papers whose abstract is related to the topic considered.
IC4	Include papers after partial or total reading.
IC5	Include papers whose publication date is after 30, June 2007.
EC1	Exclude those papers that do not match with the previous inclusion criteria.
EC2	Exclude all duplicate papers.

Table 2.5: Systematic Review - Studies inclusion and exclusion criteria definition

- *Studies type definition:* initially all studies related to ITIL V3 implementation processes will be taken into account. However, the greatest interest will focus on studies that show results on Sequence of ITIL V3 Implementation and the criteria used to determine this sequence.
- *Procedure for studies selection:* the title is the main criterion to take into account for article selection, if it does not provide enough information,

abstract section needs to be read. Finally, full article must be read if the previous information does not provide enough evidence for selection.

3.2. Selection Execution

Once the parameters of "Planning" step of the SR Review process were set, an evaluation of the review protocol was executed; this evaluation showed that the parameters defined ensure that the results obtained during the SR execution are suitable.

- *Initial Study Selection*: using search strings defined and selected sources, the search were executed. Obtained results are shown in "Found" column in Table 2.6.

Sources	Search date	Found	Relevant	Primaries
ACM Digital Library (String 1)	29/07/2014	80	5	0
ACM Digital Library (String 2)	29/07/2014	468	7	2
IEEE Computer Science Digital Library	29/07/2014	23	2	2
Springer Link	30/07/2014	43	1	1
Springer Author Mapper	30/07/2014	319	19	0
Science@Direct	30/07/2014	281	14	4
Software Engineering Institute	30/07/2017	7	1	0
ISI – Web of Knowledge	30/07/2014	44	21	0
Google	31/07/2014	11	7	0
Total		**1276**	**77**	**9**

Table 2.6: Number of studies and results retrieved from each source

- *Studies Quality Evaluation:* in order to determine the quality of the study, the author of this thesis, applying the inclusion and exclusion criteria defined in Table 2.5, has obtained the relevant and primary studies (see these columns in Table 2.6). Relevant column refers to the studies that contain IC2, IC3, IC4, EC1 and EC2; while Primary studies are the ones that contain all selection criteria. A brief list of primary studies is presented in Table 2.7; complete information about primary studies is presented in annex 2.

Next, a quality study is evaluated to obtain the assessment results that permit us to quantify those studies that effectively support the stated objectives. The previous information constitutes the study basis to continue the systematic review process, and checking the quality of the study.

Code	Primary Study Description
Ps1	"Adventures in change management: getting everyone on the same page". 2013 Stauffer, Greg; Scott, Rochelle
Ps2	"E-government: ITIL-based service management case study". 2010. Meziani, Rachid; Saleh, Imad.
Ps3	"Implementing an ITIL-Based IT Service Management Measurement System". 2010. Lahtela, Antti; Jäntti, Marko; Kaukola, Jukka.
Ps4	"An ITIL-Based IT Service Management Model for Garment Enterprises". 2008. Wang, Haining; Sun, Shouqian; Huang, Yanan; Cheng, Shiwei.
Ps5	"The status of IT service management in health care - ITIL in selected European countries". 2011. Hoerbst, Alexander; Hackl, Werner O; Blomer, Roland; Ammenwerth, Elske.
Ps6	"Implementing an IT service information management framework: The case of COTEMAR". 2012. Lucio-Nieto, Teresa; Colomo-Palacios, Ricardo; Soto-Acosta, Pedro; Popa, Simona; Amescua-Seco, Antonio.
Ps7	"Implementation of an Information Technology Infrastructure Library Process – the Resistance to Change". 2013. Esteves, Rui; Alves, Paulo.
Ps8	"Business Processes Improvement on Maintenance Management: A Case Study". 2013. Abreu, João; Ventura Martins, Paula; Fernandes, Silvia; Zacarias, Marielba.
Ps9	"Applying an ontology approach to IT service management for business-IT integration". 2012. Valiente, Maria-Cruz; Garcia-Barriocanal, Elena; Sicilia, Miguel-Angel.

Table 2.7: Systematic Review – Primary Studies.

4. Information Extraction

This section begins once primary studies are selected. Then, in this section, extraction criteria and results are described. For this purpose, the following steps need to be developed.

4.1. Information Inclusion and Exclusion Criteria Definition

Information obtained from studies must be evaluated by using the criteria listed in Table 2.8.

Acronym	Criteria Description
Inf. IC_1	Collect information about ITIL V3 processes that enterprises will be implemented.
Inf. IC_2	Collect information about ITIL V3 processes that enterprises are implementing
Inf. IC_3	Collect information about ITIL V3 processes that were implemented by enterprises.
Inf. IC_4	Classify criteria used to select the implementation of ITIL V3 processes.
Inf. EC_1	Exclusion of the information that is not related to the inclusion criteria defined above.

Table 2.8: Information Inclusion (IC inf.) and Exclusion Criteria (EC inf.)

4.2. Data Extraction Forms

To analyse data and information submitted in the selected studies, relevant remarks like title, keywords, publication date and authors of the main studies were made and recorded in a document with a sequence number identification.

4.3. Extraction Execution

According to the SR in the Software engineering process (Biolchini, Gomes, Cruz, & Horta, 2005), data extracted to the studies are two types: objective and subjective.

- Objective Results Extraction. A complete and detailed reading from these studies allowed us to organize and classify them for a later analysis. With an unbiased evaluation of the information, identified and classified studies records were generated in a structured table containing the following rows: consecutive study (sequential paper number), study methodology (remarks of the main ideas concerned with the methodology), and study outcome (data and information of the conclusion presented in each study).
- Subjective Result Extraction. The following rows where added to the previous table: data about Authors (full names and available contact information in the studies) and Additional Notes (a specific field to store general information related to the subject covered in the study).

4.4. Resolution of divergences among reviewers

In the developed procedure for the extraction of the information contained in the selected primary studies, different perceptions among authors of the studies were presented. However, none of them was considered as an important divergence, but rather, the findings were complemented to obtain a comprehensive analysis of the papers.

5. Results summarization

In order to present specific findings of this systematic review, it is important to know if research questions defined in previous sections are answered by selected primary studies (PS); for this purpose, a comparison table is made, where primary studies are analysed using the following three questions:

A. Is the Implementation performed in SMEs?
B. Is A sequence of ITIL implementation defined?
C. Are the Criteria used for sequence implementation mentioned?

Comparison results are showed in Table 2.9:

Selected Primary Studies Code	A	B	C
Ps1	○	●	◑
Ps2	◑	●	●
Ps3	●	◑	●
Ps4	◑	◑	●
Ps5	○	◑	◑
Ps6	○	●	●
Ps7	◑	●	●
Ps8	○	●	●
Ps9	○	●	●

Legend: ● Yes, ○ No, ◑ Not explicitly specified.

Table 2.9: Comparison of the publications of systematic review

In general, it can be observed that only one study mentioned that the ITIL implementation was performed in a SME; five studies were performed on large enterprises and remaining 3 studies, information about the size of enterprise was not mentioned.

In six occasions, studies mentioned explicitly an implementation sequence of ITIL processes; however, in three studies ITIL processes were mentioned as part of an implementation case study but the order were not specified.

Finally, in seven occasions one or more selection criteria were used in order to decide an implementation sequence of ITIL processes.

6. SR Final Considerations

Systematic Review Process did not found a large number of relevant studies related to ITIL implementation in SMEs. Despite this situation, it is clear that industries focused their preferences on processes that show results more quickly than another processes in ITIL life cycle, especially from the customer perspective.

Discovered selection criteria of ITIL process in SR will be useful at the moment to purpose an implementation sequence for SMEs because any of them are close related to enterprise size, on the contrary, criteria are related to the business needs and the challenge to improve the service offered to customers and the way how this situation is resolved by enterprises employees in order to satisfied customer demands.

2.3 Final Considerations of the Chapter

The state of art related to the Process Models for Services has been evaluated taking into account aspects as their structure, their flexibility to be applied in SMEs and their facility to explain how it can be implemented.

Models related to software development process like ISO 12207: Systems and software engineering -- Software life cycle processes (ISO/IEC, 2007), ISO 15504: Software Process Improvement and Capability Determination (ISO/IEC, 2004) and ISO 9001: Quality Management Systems Requirements (ISO/IEC, 2000) were not designed specifically for SMEs although since 2005 at plenary session in Finland, members of Systems and Software Engineering Committee of International Standard Organization-ISO created the Working Group 24 which will work specifically on managing and developing several objectives related to standards for SMEs (Calvo-Manzano, y otros, 2008). Two principal objectives of SC7-WG24 are the following: 1) Converting existing software engineering standards more accessible for small businesses. 2) Providing documentation that requires minimum adaptation effort. For this purpose, it would be possible to take into account maturity and capacity levels presented in ISO 15504 and CMMI or available standard process, assessment, quality and modeling of software. Standard "ISO/IEC 29110: Software engineering lifecycle profiles for very small enterprises" is the result of SC7-WG24.

A seriously gap in software engineering field has been found thanks to process models for services described in this section: an process model for services addressed to SMEs has not been created yet and at this moment does not exist intentions to create it as occurred with software development process models.

Systematic Review shows us that there not exists a model that provides a specific implementation sequence of their processes in SMEs. However, it was possible to evaluate which process model would be appropriate, thanks to its open structure to find an implementation sequence, results showed that this process model is ITIL.

Next chapters will be focused on finding an implementation sequence using the processes described in ITIL books. This sequence needs to be appropriate for implementing best software practices in SMEs without the traditional problems that introduce the big process models.

Two strategies will be used to define an ITIL implementation sequence: deep study of selected primary studies in the systematic review and a survey conduction addressed to software engineering experts and enterprises around the world which started an ITIL implementation.

After analysing and adjusting an implementation sequence, a real case study will be performed in an Ecuadorian SME.

CHAPTER 3

RESEARCH METHODOLOGY, ACTIVITIES AND EXPECTED RESULTS

This chapter presents the research methodology used to address the research sub-questions. According to Basili's framework, research methodology is presented using four phases: definition, planning, operation and interpretation. Each phase is clearly described, it means that the deliverables and outcomes are mentioned too.

The Case study definition is included in this chapter. It constitutes the main research technique used during the execution of the research activities.

3.1 Research methodology and expected results

The goal of the research methodology is to be used to address the proposed research question and sub-questions from Chapter 1. The framework for experimentation described by Basili intends structuring the experimental process providing a classification schema for understanding and evaluating experimental studies (Basili, Selby, & Hutchens, 1986) (Basili & W, 1991). The overview of the resulting knowledge of the experiment the lessons learned in the experimentation and the problem areas identified are some results of applying the four phases of the Basili's framework: definition, planning, operation and interpretation. Next, each phase is going to be explained.

3.1.1 Definition Phase

This phase is related to motivations, purposes or perspectives associated to the research. This phase is composed of the following activities:

- To identify and understand the problem;
- To define a research topic that allows to give an original contribution to knowledge;
- To Formulate the research questions and research sub-questions; and

- To envisioned a potential solution to the problem.

Study definition of this master thesis is detailed in Table 3.1

Element Definition	Element Description
Motivation	How can an ITIL implementation sequence be represented to suit better the constraints of SMEs?
Objective	In order to contribute the creation of the strategy for implementing ITIL in SMEs environments.
Proposal	• An ITIL implementation sequence for SMEs • An implementation strategy of the first ITIL process in the sequence.
Research Users	Small and Medium enterprises of all kind of industries. Process Models experts and researchers. Software engineering and IT professionals.

Table 3.1: Definition phase - Research methodology

3.1.2 Planning Phase

Conduction of a Systematic Review was part of this phase. Topics covered by this activity were:

1. Definition of Process and Process models for services.
2. State of the art related to Process models for services.
3. Approaches proposed for ITIL implementation in SMEs.
4. State of the art related to ITIL implementation cases.
5. Approaches related to selection criteria of ITIL processes in the sequence.

For the first research objective, the focus of the systematic review was on identifying what has already been done: 1) the few efforts of implementing ITIL in SMEs contrast to the implementation carried out in large enterprises; and 2) the different criteria to select an ITIL processes to be implemented. In general, there is no evidence about specific ITIL implementation sequence for SMEs.

As a consequence of previous findings, it is necessary to use other research method in order to find evidence for the second research objective. Information related to the most suggested criteria to select ITIL processes, obtained as a consequence of research objective one, is valuable to following research activities.

A summary of this phase is presented in Table 3.2 and Table 3.3.

Project Steps	Inputs	Deliverables
Conduct a Survey (Survey A)	• ITIL Processes • Questionnaire	Survey A results.
Development an ITIL implementation sequence	• Systematic Review • Survey results.	ITIL implementation sequence
Selection of the first ITIL process in the sequence.	Proposed ITIL implementation sequence.	First ITIL process to implement.

Table 3.2: Plannig phase - Research goal one

Project Steps	Inputs	Deliverables
Designing an implementation strategy of the first selected ITIL process.	• Selected ITIL process • ISO 29110 standard.	Implementation strategy.
Evaluation of strategy • A case study • A survey (Survey B)	Implementation strategy	• Propositions to be tested by survey. • Points of view of experts or researches. • Improved strategy. • Lessons learned. • Enterprise observations.

Table 3.3: Planning phase - Research goal two

3.1.3 Operation Phase

Within the operation phase, the research plan is executed. This phase includes two parts, one for each main deliverable:

1. The development of a proposal for an ITIL implementation sequence for SMEs.
2. The development of an implementation strategy of the first ITIL process in the sequence.

Each part includes two steps: 1) a validation of the deliverables; and 2) an analysis of the results. A summary is showed in Table 3.4 and Table 3.5.

The ITIL implementation sequence for SMEs is developed based on the results of the systematic review. This sequence includes the definition of the most used criteria to select the processes. Then, the implementation sequence is evaluated taking into consideration results of conducted survey to experts and enterprises. The survey, called "Survey A", is conducted in an open style, therefore, it is always available in the cloud. Instructions were send by email to the participants because questionnaire was easy to fill. The participants of the survey are practitioners with practical experience on ITIL and experts with theoretical experience on ITIL or software process models in general. The results of the survey took us further to evaluate the selection criteria used to perform the process selection according to different points of view, obtaining more criteria than in the systematic review. The result was a reviewed ITIL implementation sequence for SMEs.

Development	Validation	Analysis
Development an ITIL implementation sequence	Implementation sequence is evaluated by conducting a survey "Survey A" addressed to researches, experts and enterprises around the world. The questionnaire of the survey is based on the research questions used in the systematic review.	Reviewed of primary studies obtained in systematic review.

Table 3.4: Operation Phase - Development of ITIL implementation sequence

The development of an implementation strategy of the first ITIL process in the sequence starts when the selection of the process is performed. Therefore, it will be justified why the first process in the sequence is the selected one to develop a strategic. In order to justify the strategy development, the complexity of implementing the ITIL process was analyzed. Additionally, the standard related to lifecycle profiles for Software engineering developed to very small organizations was examined in detail; in order to use the structure of the standard in the strategy development.

Then, a case study helps to verify the approach to the implementation strategy. Also, it allows to know the current situation of service provision in the participant enterprise. As a result of this case study, strategy can be modified but the most important feedback will be to know the level of implementation of the ITIL process that the enterprise achieves using the proposed strategy. The "Survey B" is conducted following a semi-

supervised format: therefore, it is conducted as a workshop. The survey helps to test a set of propositions derived from the application of the implementation strategy of the first ITIL process.

The design of the "Survey B" is presented in section 3.3.

The summary of the operation phase is described in the Table 3.5.

Development	Validation	Analysis
Development of an implementation strategy of the first ITIL process in the sequence.	• ITIL process is evaluated in order to know its complexity. • ISO 29110 is evaluated in order to know about the structure of the standard developed for SMEs. • Implementation strategy is evaluated by a case study performed in an Ecuadorian small enterprise. The case study is conducted following an action research methodology. The perceptions of participants of the enterprise are recorded. • A survey "Survey B" is provided to participants. The questions of this survey are based on the set of propositions derived from the case study.	• Knowing the activities, description and complexity of the selected ITIL process. • Knowing how to use the structure of modelling a new strategy. • Publications of the results.

Table 3.5: Operation Phase - Development of implementation strategy

3.1.4 Interpretation Phase

Finally, an interpretation based on analysis of all the findings and feedbacks is performed. In this phase, each of the research sub-questions are reviewed, the findings are documented, and future work is identified.

3.2 Design of the Case Study

Based on the recommendations by (Runeson & Höster, 2009) and (Yin, 2002), the case study reported in this research has been designed and conducted. Also, this creates an increase the validity of the results.

Two researchers (the author and the director of this thesis) were involved in the performance of the case study reported in the thesis.

The case study followed an action research methodology (Baskerville & MD, 2004): therefore, researchers together with the members of the participant enterprise collaborated in the strategy implementation. The action research methodology aims at acquiring new knowledge but at the same time providing value to the participant enterprise (Sjoberg, Dyba, & Jorgensen, 2007). The action research approach has been extensively used for information systems research (Baskerville & MD, 2004) (Davison, R; Martinsons, MG; Kock, N, 2004), and it is considered a valid case study methodology for empirical software engineering research (Runeson & Höster, 2009) (Sjoberg, Dyba, & Jorgensen, 2007). The guidelines proposed by Runeson and Höst (2009) for "reporting case study research in software engineering" have been considered to report the case study conducted as part of this master thesis.

The case study was conducted following the principles of canonical action research (Davison, Martinsons, & N, 2004): 1) a verbal agreement between the research members and the participant enterprise is established; 2) a theoretical framework is used as a basis for the research process; 3) an iterative model leads the research process; 4) at each iteration the outcomes are analyzed to learn from them; and 5) actions are taken based on the interpretation of the outcomes.

During a first meeting-activity: the main contacts of the participant enterprise were introduced to the research group, the methodology proposed to conduct the case study was discussed, important issues regarding the organizational culture of the participant enterprise were discussed, and the access to the sources of information was demanded and granted. For the case study the implementation strategy was developed by the results of: 1) Analysis of the first ITIL process in the proposed implementation sequence; and 2) the focused evaluation of the structure of standard ISO 29110.

Research objectives of the case study are: 1) to test the implementation strategic based on profiles schema contributes to motivate ITIL implementation initiatives in SMEs; and 2) to empirically evaluate the implementation strategy in a real initiative ITIL implementation. Based on these objectives, a set of research questions were formulated in order to guide its execution.

The unit of analysis for the case study is the ITIL process selected by the previous stage in the thesis.

Evidence was collected through the analysis of: 1) existing files from the participant enterprise (e.g., documents, web site, etc.); 2) discussions and feedbacks from the members of the participant enterprise; 3) observation of how the work is performed within the participant enterprise; and 4) observation of the implementation process. All relevant data were recorded and maintained (Runeson & Höster, 2009). The knowledge that emerged from this process was documented. The members of the participant enterprise were allowed to review the results.

Four types of meeting-activities were identified for conducting the case study: discussion, interview, evaluation, and research-group meetings. Data were collected during all of these types of meeting-activities. When necessary, research instruments for guiding the various meeting-activities were elaborated. For instance, interview guidelines were prepared for the interview meetings.

3.3 Design of a Survey

The design objective of this survey is to test a set of research propositions formulated based on the findings from the case study.

The survey was planned to be conducted following a semi-supervised format like a workshop within a normal day of labor in the enterprise. The execution of this workshop-survey was distributed as follows: 1) presentation of the motivation, background and research objective of the survey-workshop; 2) description of the activity and its instructions; and 3) execution of the survey: filling the questionnaires. The first two activities were executed by the author of this thesis, who was available on site during all the workshop-survey to answer any question from the participants.

3.4 Summary of the research methodology

In summary, the research methodology used in this thesis is twofold: 1) the methodology followed for the design of the ITIL implementation sequence; and 2) the methodology followed to develop the implementation strategy of the first ITIL process of the implementation sequence. A resume approach of the research methodology is described in Figure 3.1.

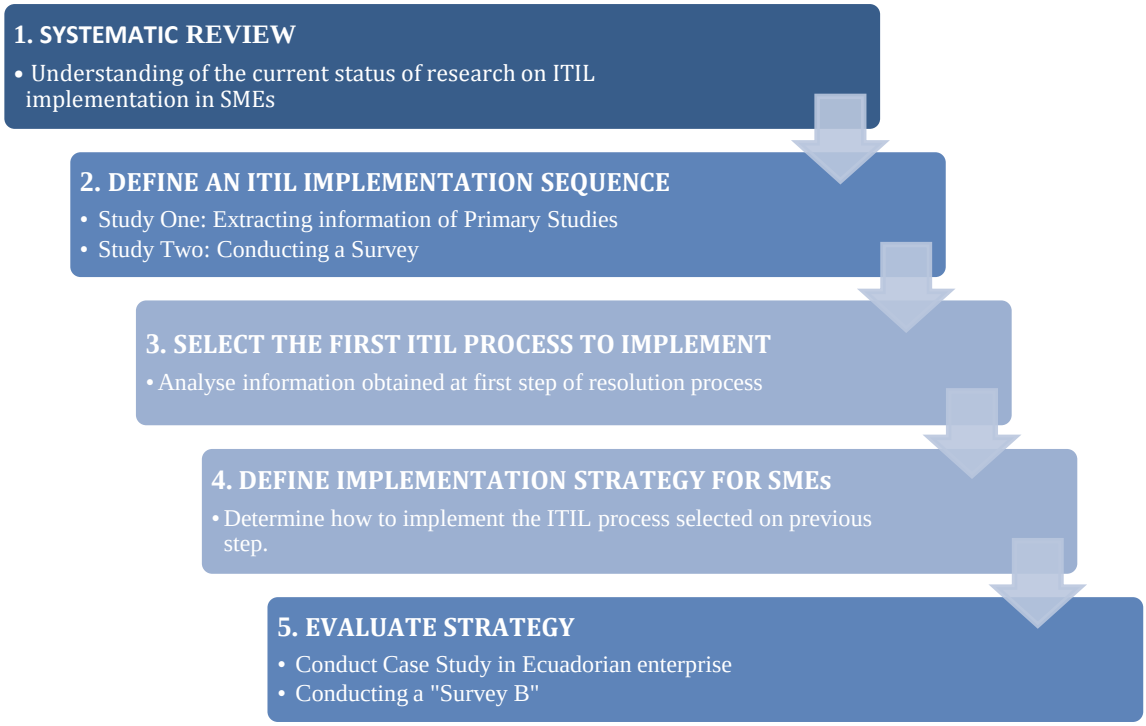


Figure 3.1: Research Methodology Diagram

CHAPTER 4

BUILDING THE IMPLEMENTATION STRATEGY

In this chapter, an ITIL implementation sequence is drawn upon results of the systematic review. This sequence represents one of the two contributions of this thesis. Also, the proposed sequence is reviewed through a survey. In short words, three of the four stages in the research methodology are developed in this chapter.

4.1 An ITIL Implementation Sequence

As described in the chapter one and three, knowing more about the current situation of ITIL implementation through a systematic review is a key factor in this master thesis. This translates into a building process of implementation which is a part of the research methodology.

From literature, we learned that the ITIL framework provides us a structure which will allow to construct a proposal of process implementation sequence in Small and Medium Enterprises. During the systematic review, we learned that there exists 9 scientific publications related to ITIL implementation. Using this knowledge as an input, next activity in research methodology is explained in the following sections.

4.1.1 Activity Two: Define the ITIL Implementation sequence

Formal studies and experts opinions indicate decisions the researchers and software professionals faced during a formal ITIL implementation project initiative; it means this activity will facilitate the understanding of the research status on the topic and will address further resolution of raised questions in this thesis.

In this activity, two studies were conducted. Study one consists in developing a deep analysis of primary studies obtained as a result of a systematic review presented in the chapter two. This activity will let us knowing about which is the process implementation sequence used in cases studies described by the authors in the primary studies. Study two consists in conducting a survey in order to evaluate results of study

one and to get recommendations of software engineering experts and the experiences of enterprises that decided to implement ITIL by their own.

4.1.1.1 Study One: Extracting Information of Primary Studies

Primary Studies (PS) are a set of studies and publications selected during the systematic review conduction. Synthesized phases of Systematic Review are shown in Figure 4.1. These phases permit us to obtain the following results on each phase: at phase one, denominated "Search Term", 1,276 studies were founded inside 7 publication databases; in phase 2, relevant studies were selected through "title and abstract exclusion", this is, 77 relevant studies were found; finally, relevant studies full text reading filtered only 9 primary studies.

Detailed evaluation on each primary study established nine different ITIL process implementation sequences which were consolidated in a single sequence.

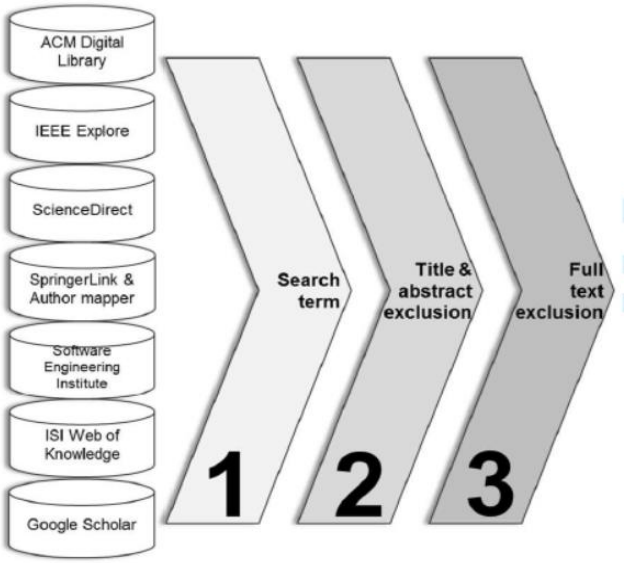


Figure 4.1: Synthesized phases of systematic review

4.1.1.1.1 Study One: Delimitation

Using the third phase output, a new procedure for extracting information was started. The goal of this procedure is to identify what implementation sequences were applied or recommended by PS authors. It was possible to get them by using a detailed and deep reading of each article as an extraction information technique. Additionally, some rules were defined in order to keep equality examination for all PS as following:

- Data will be extracted in spite of case study was not performed in a SME.

- When an implementation sequence does not mention explicitly along PS, sequence should be constructed according to the order of appearance of ITIL processes in the primary study.
- All selection criteria mentioned by PS's authors at the moment of selecting the ITIL process should be considered as a part of the final criteria list in order of importance.
- When selection criteria importance is not mention in a specific order or prioritization, this should be determined by the order of appearance in the PS.

4.1.1.1.2 Study One: Results

After an exhaustive reading of each PS, a matrix was constructed. On the left side of the matrix, the ITIL processes mentioned in the PS were listed. Only 7 out of the 26 ITIL processes were mentioned in the primary studies. On the right side of the matrix, three columns were placed. In these columns, only the number of times each ITIL process was mentioned in the PS according to its sequence is taken into account: this means, first, second or third place in the sequence. Results are resumed in Table 4.1 and Figure 4.2

ITIL Processes	Implementation Sequence		
	First Place	Second Phase	Third Place
Incidence Management	7	0	0
Problem Management	2	1	1
Configuration Management	1	1	0
Change Management	1	1	0
Request Fulfilment	0	2	1
Service Level Management	0	0	2
Knowledge Management	0	0	1

Table 4.1: Study One Results

ITIL implementation sequence is: Incident Management Process, Request Fulfillment Process, and Service Level Management Process.

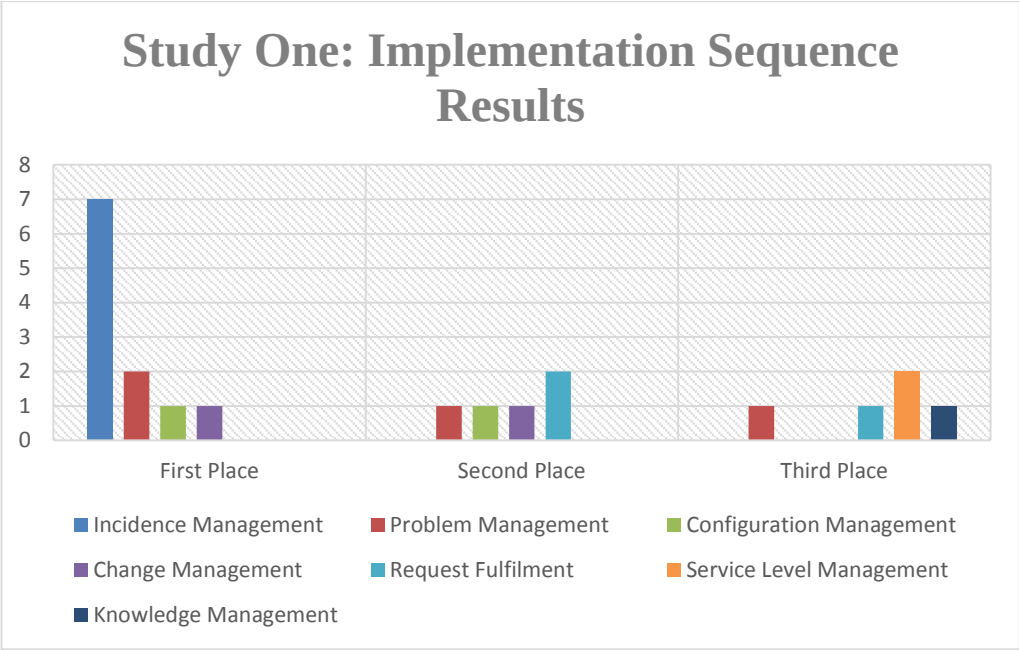


Figure 4.2: Study One Implementation Sequence Results

About the criteria used in order to select the order of implementation of ITIL processes, seven criteria were identified in PS (see Figure 4.3), although sometimes more than one criterion was mentioned per study and twice any criterion was explicitly specified. Thus, Business needs and Quick wins are the most suggested criteria by the authors; also criteria as Customer Demands, Strengthen Service Support and Feasibility are suggested too.

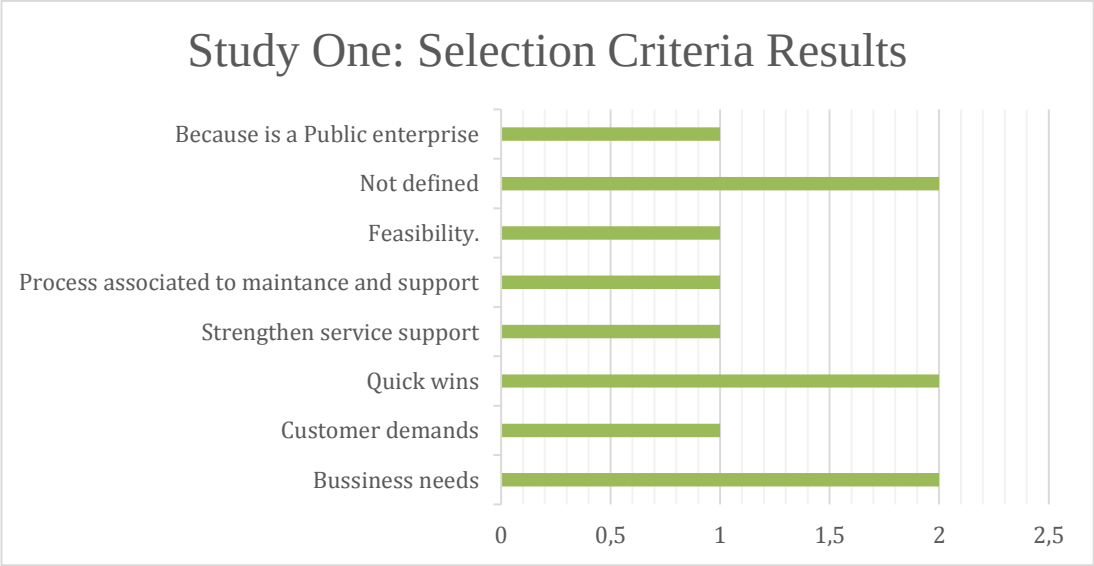


Figure 4.3: Study One selection criteria results

4.1.1.2 Study Two: Conducting a Survey

A survey can characterize the knowledge, attitudes, and behaviors of a large group of people through the study of a subset of them. For this reason, surveys are used extensively by software and systems engineering organizations to provide insight into complex issues, assist with problem-solving, and support effective decision making (Kasunic, 2005).

This survey has two goals: 1) to evaluate the implementation sequence proposed by the study one; 2) to take into account the opinion about the ITIL implementation sequence of experts (professionals in software engineering, software engineering teachers, etc.) and real ITIL implementation cases performed in enterprises that have not been presented in scientific publications because the enterprise considered the ITIL implementation as an enterprise internal project where the implementation reasons are related to the enterprise needs at a specific time.

The Questions were carried out as a part of Study two denominated "Exploratory Study: ITIL for Small and Medium enterprises".

4.1.1.2.1 Study Two: Survey Planning

One concern that the authors had to resolve before constructing the questionnaire for the survey was to determine which should be the ITIL processes to be considered in the questions. ITIL framework is conforms by 26 processes. The idea was to focus the survey on just the ones that will be of importance in the context of SMEs. For this aim, a delimitation procedure of ITIL processes was conducted.

Processes Delimitation

A processes delimitation procedure was carried out with the help of five professionals with experience in ITIL application in small software companies who were selected on the basis of their experience. The subjects were selected from those who answered positively to a personal invitation sent by the authors among their personal contacts. The average age of the sample was 42.2 years old. One participant was female and four were male. Participants' nationalities were: Spanish (3), Mexican (1) and Brazilian (1).

Then, a Delphi study was performed. Delphi study consisted of choosing the most important processes from the 26 presented in ITIL. The meeting was performed via videoconference. In the first round, an initial record was obtained based on responses from the experts. This record was later presented to panelists in the second round, who had to agree on a group response. Subjects took 22 minutes on average to complete these two rounds.

Agreeing et.al. (Colomo-Palacios, Casado-Lumbreras, Soto-Acosta, S, & FJ, 2012), Delphi studies are affected by their own threats to validity that arise from pressures for convergence of predictions, but in this case, the level of expertise and common interest in the topic help to increase the content validity. Regarding internal validity, we ensured a similar level of knowledge among participants. Finally, regarding external validity, we believe that the sampling method is acceptable in terms of number and diversity.

According to panelists, the list of processes to be considered in the survey is as follows:

1. Service Portfolio Management Process.
2. Financial Management for IT Services Process.
3. Demand Management Process.
4. Service Catalogue Management Process.
5. Service Level Management Process.
6. Availability Management Process.
7. Capacity Management Process.
8. IT Service Continuity Management Process.
9. Information Security Management Process.
10. Supplier Management Process.
11. Change Management Process.
12. Service Asset and Configuration Management Process.
13. Release and Deployment Management Process.
14. Knowledge Management Process.
15. Event Management Process.
16. Incident Management Process.
17. Request Fulfillment Process.
18. Problem Management Process.
19. Access Management Process.

20. Continual Service Improvement.

Once the Processes Delimitation Procedure was finished, next step in the survey planning was the questionnaire construction.

Questionnaire

The questionnaire was created with the Lime Survey platform, which enables the construction of electronic online questionnaires. In the survey a set of introductory and sample data is formulated, including the country of the respondent. In addition, the experts were asked to choose whether they were answering as individual experts or in the name of their company. The list of 20 ITIL processes from Delimitation Procedure was presented and experts were asked to choose the first 3-5 processes from that. Finally, the subject was asked to provide the criteria used for selecting these processes.

Data Collection

As stated before, an online survey was employed in the study two. A solicitation letter was transmitted by e-mail to a set of contacts during June and October of 2014. The authors invited experienced individuals (according to their profiles) to answer the survey. The e-mail sent, described the purpose of the research while inviting each receiver to participate in the survey by clicking on a link. The responses from 47 participants were collected on the web. According to the number of responses received, the validity of results was 85.11%. At the end, 40 responses obtained were complete and valid.

Threads to Validity

Several threats to validity were identified, and will be presented below. Regarding content validity, a pilot questionnaire was made prior to the final implementation of the instrument to enhance the questionnaire. The sample for this study was composed of three ITIL experts. The process ended with an enhancement of the questionnaire in terms of expressions. This process can be applicable also to construct validity and reliability, which are tackled by a multiple tests to the questionnaire.

With regards to conclusion validity, we considered that, given the composition and size of the sample, it is representative and significant enough for the aims of this stage. Concerning internal validity, the respondents were in all cases chosen because of their expertise, experience, and we believe that (given that all respondents are ITIL certified) they may present comparable levels of knowledge or expertise on the topic.

Finally, on the subject of external validity, two different threats are assumed. The first is the size of the sample, which can complicate the generalization of the results. The second is the fact that the sample was not taken randomly; it depended on the selection of us.

4.1.1.2.2 Study Two: Results

After survey data tabulating (see Table 4.2), which was composed by 40 respondents, result matrix was constructed. It was constructed using the same format used for Study One. Also, an illustration which shows a data distribution by country is presented in Figure 4.4.

ITIL Processes	Implementation Sequence		
	First Place	Second Phase	Third Place
1. Service Portfolio Management Process.	7	3	1
2. Financial Management for IT Services Process.	3	3	1
3. Demand Management Process.	6	0	0
4. Service Catalogue Management Process.	6	9	5
5. Service Level Management Process.	1	9	3
6. Availability Management Process.	0	1	3
7. Capacity Management Process.	1	1	1
8. IT Service Continuity Management Process.	1	2	2
9. Information Security Management Process.	0	1	2
10. Supplier Management Process.	0	0	0
11. Change Management Process.	2	3	6
12. Service Asset and Configuration Management Process.	1	3	8
13. Release and Deployment Management Process.	0	1	1
14. Knowledge Management Process.	0	0	1
15. Event Management Process.	0	1	1
16. Incident Management Process.	8	2	2
17. Request Fulfillment Process.	2	0	3
18. Problem Management Process.	0	2	0
19. Access Management Process.	0	0	0
20. Continual Service Improvement.	2	0	0

Table 4.2: Study Two: survey data

After these results, the three first places of proposed ITIL implementation sequence according to Study Two are: Incident Management Process, Service Level Management process or Service Catalogue Management (these processes are both the second most suggested), and Service Asset and Configuration Management Process. Figure 4.5 shows an illustration of this result.

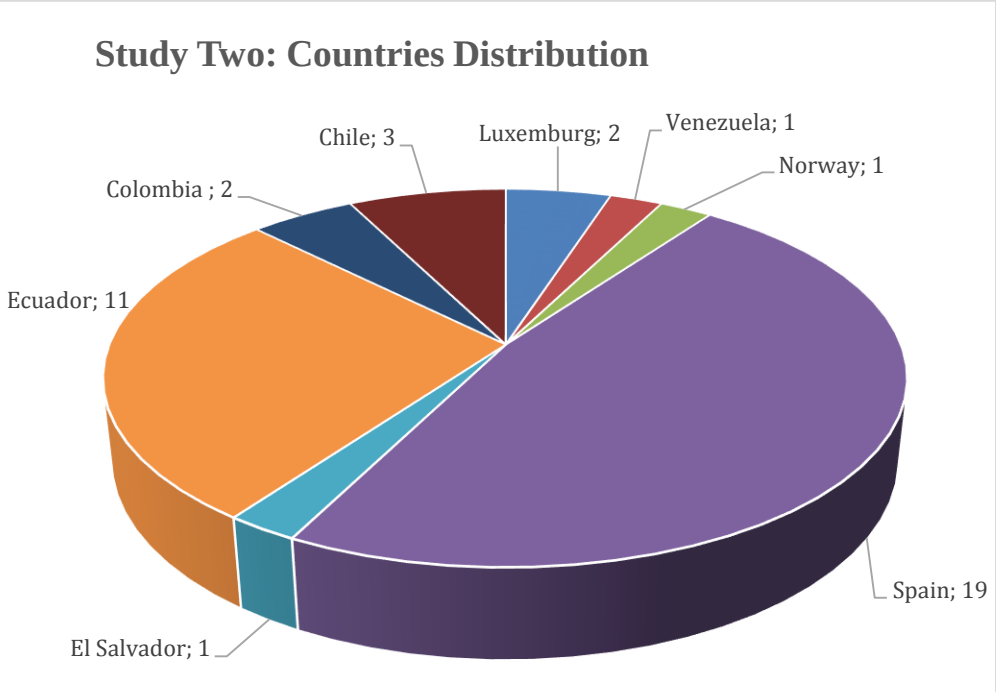


Figure 4.4: Study Two: Survey answers by country

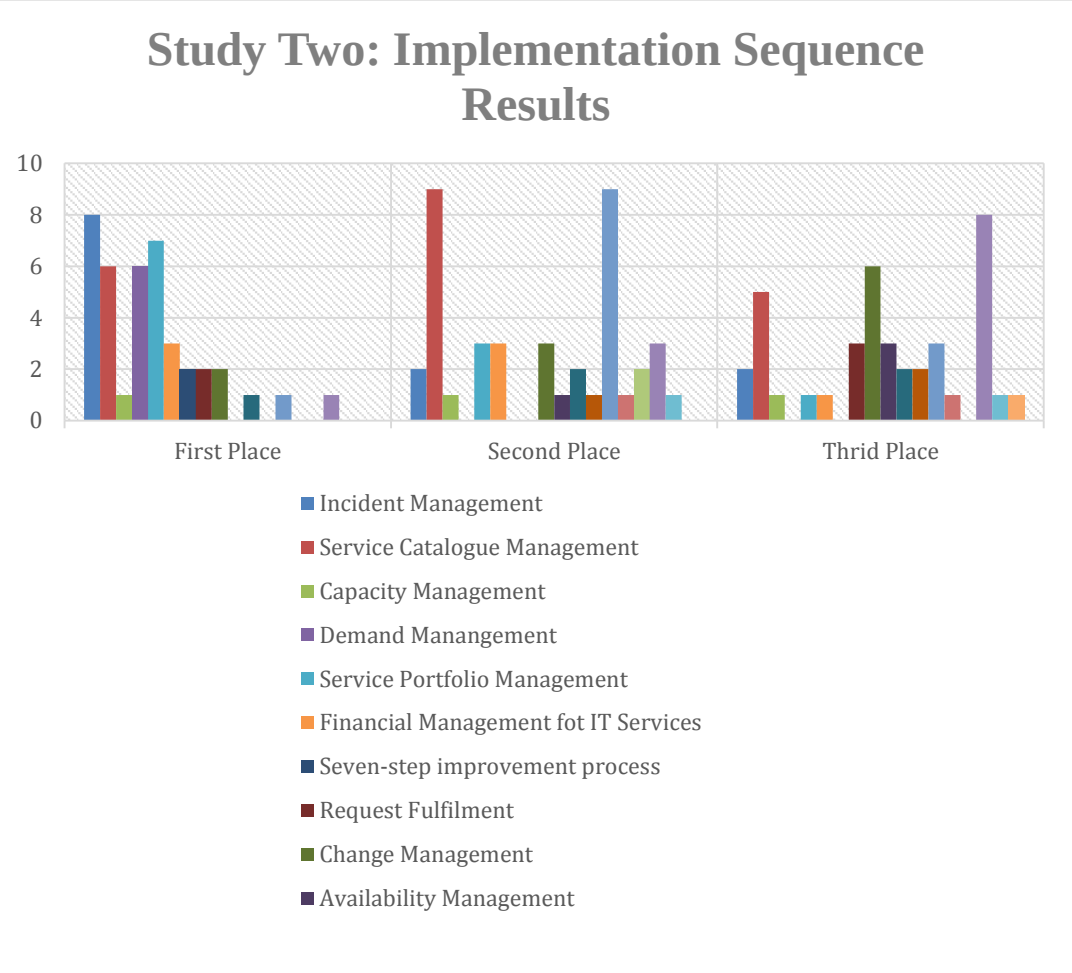


Figure 4.5: Survey Two: Implementation sequence results

Related to the criteria used to select the implementation order of ITIL processes, 10 criteria were used by the respondents, although sometimes more than one criterion was mentioned per response. Thus, "Quick wins" is the criterion most reported by experts; criteria such as Strengthen Service Support, Customer Services and Demands Prioritization are suggested too. These results are showed in the Figure 4.6.

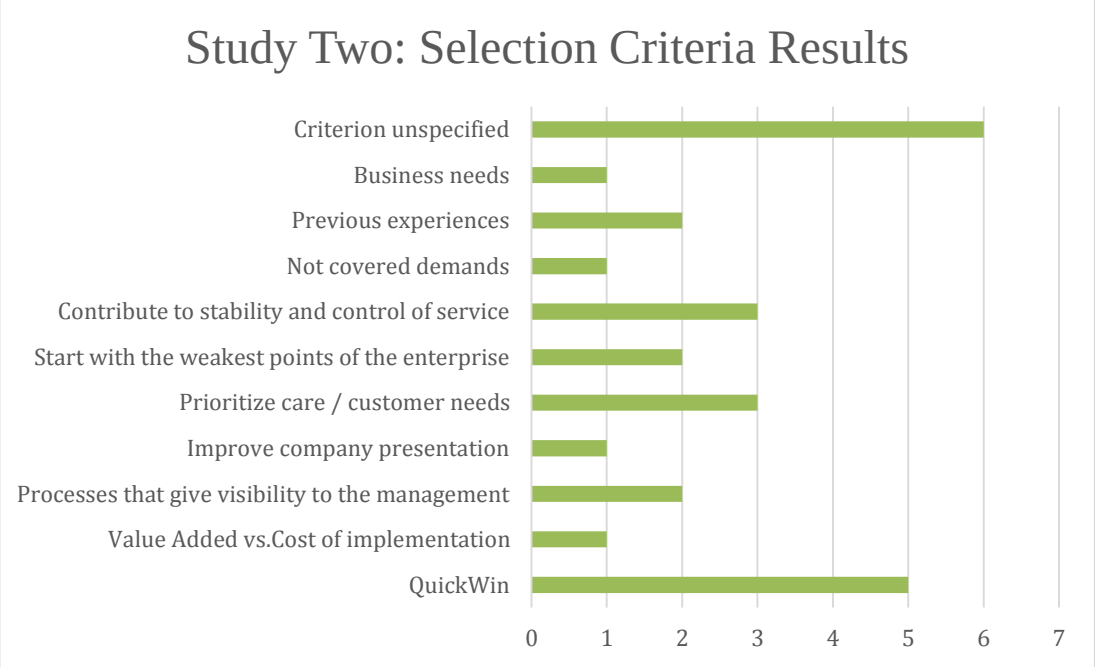


Figure 4.6: Study Two Selection Criteria results

4.1.2 Activity Three: Selection of the first ITIL process to be implemented

After the results of study one and study two are presented, it is possible to consolidate ITIL implementation sequence proposal such as follows:

Sequence Number	Process Implementation Sequence		
	First Place	Second Place	Third Place
Study One Sequence	Incident Management	Request Fulfillment	Service Level Management
Study Two Sequence	Incident Management	Service Level Management	Service Asset and Configuration Management

Table 4.3: ITIL implementation Sequence consolidation

Studies results agree that the Incident Management Process is the first ITIL process to be implemented, second and third place are different in each sequence. However, it is important to know that this sequence are not specifically for SMEs.

Every year more and more organizations want to implement ITIL. However a considerable percentage of them fails and some organizations collapse trying it (Nicewicz-Modrzewska & Stolarski, 2008). Thanks to the research investigation we have determined that the Incident Management process is the first ITIL process that all size enterprises can use as starting point at the moment they face an ITIL implementation. This is a finding that is aligned with Marrone et al. (Marrone, M; Gacenga, F; Cater-Steel, A; Kolbe, L, 2014), who note that Incident Management is adopted by 95% of organizations using ITIL. However, we believe that the reasons for choosing this process are rooted in the fact that this process shows results more quickly than other processes related to the ITIL life cycle, especially from the customer perspective, through increased user satisfaction. This case has been reflected in the literature and highlighted by Valiente et al. (Valiente, Garcia-Barriocanal, & Sicilia, 2012), who emphasize that incident management is one of the main candidates as a starting point, given that it is highly visible to the business, and it is therefore easier to demonstrate its value.

Thus, criteria for ITIL implementation are related to the business needs and the challenge to improve the service offered to customers and the way this situation is resolved by enterprise employees in order to satisfy customer demands.

The strategy for implementing Incident Management Process according to the SMEs approach will be presented in the next section.

4.2 An Incident Management Implementation Strategy

As a result of the previous activity described in the research methodology, Incident Management Process is the first process of ITIL to be implemented in a SME.

Then, as the second research objective mentions, the development of a strategic that allows SMEs to implement the Incident Management Process is the next key factor in this research work. For this propose, activity four of the research methodology plan is described in the following sections.

4.2.1 Activity Four: Defining the implementation strategy for SMEs

According to the operation phase of the research methodology, it is important to know all details about the selected ITIL process and the structure template that provide us the guide to design the implementation strategy. This can be possible analysing: 1) the

Incident management process according to ITIL publications; 2) the structure of the standard for Lifecycles profiles for very small enterprises – ISO 29110 (ISO/IEC, 2011).

A combination of these two concepts allows us to design an implementation strategy that adjusts to the SMEs context and provides to the SMEs a starting point for ITIL implementation initiatives.

4.2.1.1 Incident Management Process

The Incident Management Process belongs to The ITIL Service Operation publication. This publication describes guidance on how to maintain stability in service operation (OGC, 2011). The delivery and service support are the main objectives of this publication which ensures the service value to the customers, users and service provider. For this purpose, ITIL provides to all its process, several information that helps enterprise practitioners to introduce best practices and a complete process implementation. Items that conforms the process description are: 1) purpose, objectives, scope; 2) value to business; 3) policies, principles and basic concepts; 4) process activities, methods, techniques; 5) triggers, inputs, outputs, interfaces; 6) information management; 7) critical success factors, key performance indicators; and 8) challenges and risks.

Incident Management process is one of the five processes which depends the effective service operation. It concentrates on restoring unexpectedly degraded or disrupted services to users as quickly as possible, in order to minimize business impact (OGC, 2011). In other words, the importance of this process is based on decreasing the service downtime which in turn means higher availability of the service. Therefore, it will be easier to demonstrate the value of the incident management process that the value of most areas in the service operation.

ITIL Service Operation publication considers that results of incident management implementation are highly visible to the business (OGC, 2011). This affirmation agrees with criteria obtained as a result in the systematic review process performed and in the "survey A". Criteria are: Quick wins, contribute to stability and control of service, customer needs prioritization and business needs.

Another strong point for implementing Incident Management at first place when an ITIL implementation starts in a SME is its interaction between other ITIL processes in different phases of the lifecycle. Knowing the contribution of the Incidence Management process over other processes allows assessing how useful is its implementation to the business; this information can be crucial to select the next process to be implemented in the enterprise.

Interaction between other processes and Incident Management is shown in the Figure 4.7. Notice that the processes are classified according the phase in the ITIL lifecycle. The Incident Management process cannot only triggering output events or obtain information of other processes (like problem management process, change management process, etc.), but also it could receive input events (event management process and service desk function).

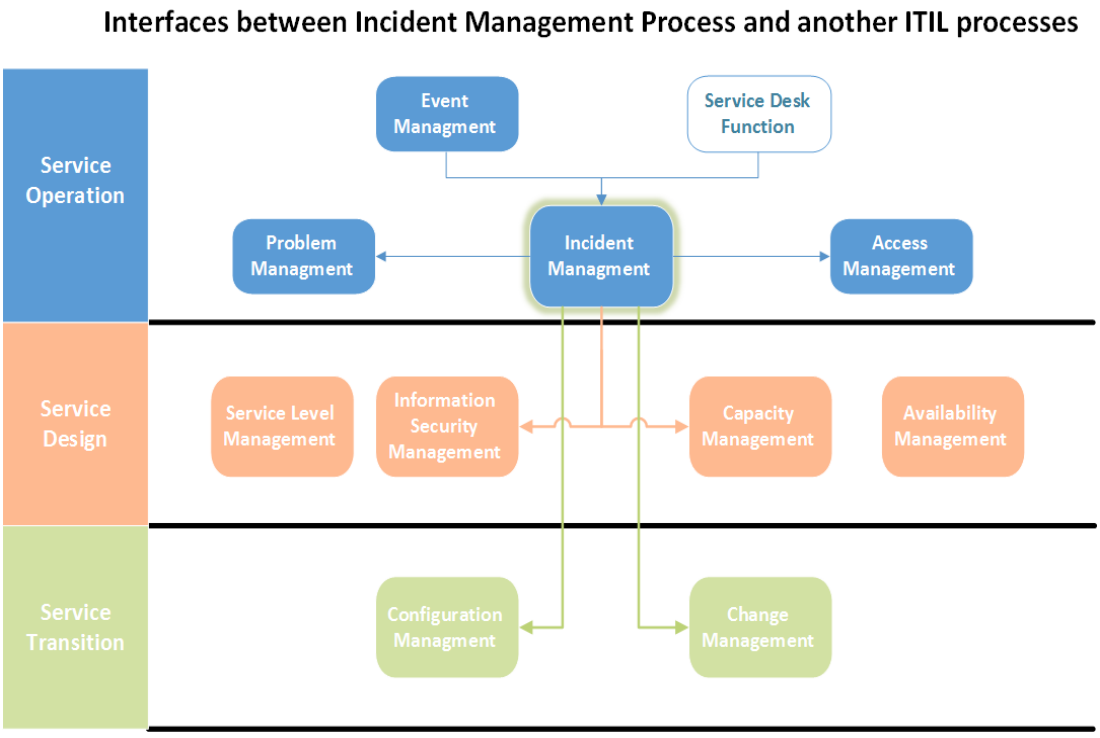


Figure 4.7: Interaction between Incident Management and other ITIL processes

More details about Incident Management interfaces are explained in the following sections.

In order to achieve the goals defined by ITIL, incident process takes the responsibility for managing the life cycle of all incidents. But, what is an Incident?

4.2.1.1.1 Incident Definition

According to the ITIL terminology (OGC, 2011) an incident is *"an unplanned interruption (event) to an IT service or reduction in the quality of an IT service or a failure of a configuration item that has not yet impacted an IT service"*. The event that produces an incident can be related to hardware or software components in the service. Incidents are usually more visible and the impact on the user is more immediate; commonly user described it as: a fault, an error, something does not work or a problem. When an incident occurs many times or affects many users is denominated a Problem. A problem should be managed by the Problem Management Process despite of it can be reported as an incidence.

There exists three ways to detect an incident. Figure 4.8 shows that two actors can notify incidents: the user and applications. User can communicate, through email, telephone or specialized application, to two kinds of actors at the moment of detecting an incident: Service Desk or Service Department, this depends on the enterprise structure. Some applications are designed for monitoring and detecting events, and they are an important component to detect incidents before they impact the user. Probably, SMEs does not have this kind of applications.

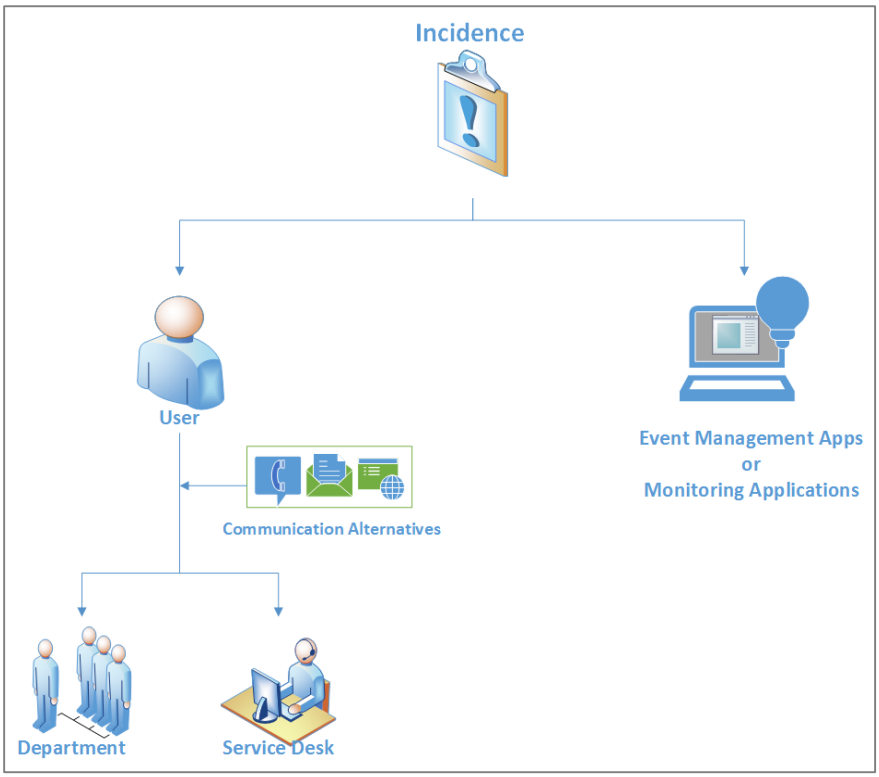


Figure 4.8: Incident Communication

Service Desk Role

It is a point of communication between services users and services provider that is considered in key in some aspects in the business, especially during the incident lifecycle. In ITIL terms, service desk is not defined as a process, it is defined as a Function. Functions are units of organizations specialized to perform certain types of work and responsible for specific outcomes, characterized for special area of knowledge or experience (OGC, 2011).

A variety of services activities are dealing by the service desk function. That means, it not only handles incidents, it may also provide an interface for other activities such as customer change request, maintenance contracts, software license, availability management, financial management, so their value should not underestimated. However, the organization of this unit depends on the nature of the enterprise. For example, in large enterprises, service desk usually represents a first-line IT support issue and it is composed of technical staff. Meanwhile in the SMEs, the structure of service desk represents another implementation challenge closely related to: the business needs; the scope of services provided by SME; and the processes that will be covered by it. In the case of this master thesis, Service desk can identify additional services or training requirements as a secondary priority, when the incidents are handled.

Nevertheless, benefits of the service desk implementation are undeniable: the customer service, perception and satisfaction is improved; teamwork and communication is also improved; negative business impact is reduced; infrastructure and control are better managed; information for decision support are more meaningful managed, among others.

4.2.1.1.2 Activities of the Incident Management Process

As mentioned previously, a process is composed by a list of activities. So, processes are a cluster of activities organizes in a meaningful, logical, effective and efficient sequence to realize a pre-defined objective. In this sense, a process is a series of activities carried out to convert an input into an output and ultimately into an outcome. In Figure 4.9 a generic view of a process structure is shown. The presence of activities or sequence of activities is identified in the purple square. Also we can notice that a

specific activity of the process could be performed because: 1) the service control or quality of the desired output is necessary; and 2) it is a trigger from customer.

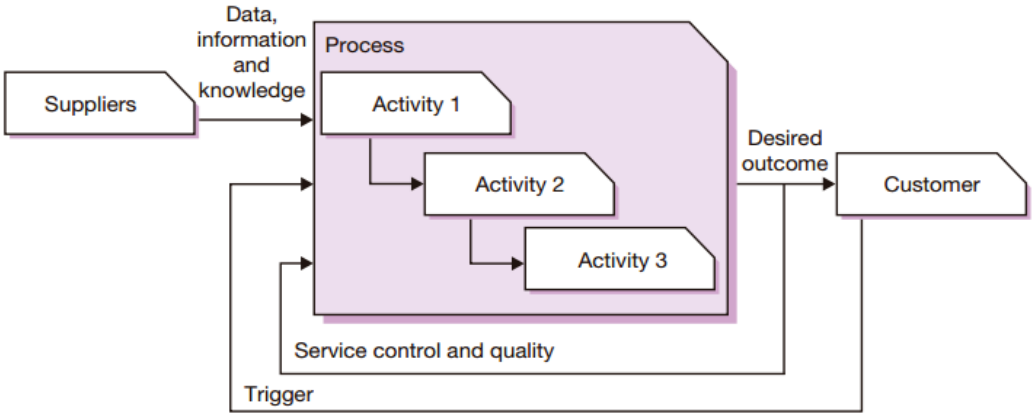


Figure 4.9: Basic Process Structure (OGC, 2011).

Activities can be denominated in two ways: operational activities concerned with the throughput, converting input to output, well known as "activities to realize a goal"; and the activities to make sure that the operational activities are performed, it is called "control activities".

Ten operational activities are defined in the incident management process. We can say that each activity represents one step in the incident lifecycle. Hence, in each activity the appropriate way to handle incidents according to its current status is defined in detail. Activities are defined in order to perform one after another, but it is possible to decide that the first activities to implement are those related to business expectations. Now, this section focuses on describing the activities of the process, additionally, the Figure 4.10 shows a representative graph of them.

Figure 4.10: Operational Activities of Incident Management (OGC, 2011).

The first activity is related to **incident identification**. This starting point marks the route to perform a successful resolution of the incident because if the incident is detected quickly, it can be resolved before impacting the user. This can be the ideal way to manage incidents. For this purpose, all key components of the services should be monitored, so failures or potential failures are detected early.

Regardless of the origin of **incident, performing a logging** of all their information is mandatory. Maintaining a full history is the goal of this activity. The following fields can be filled at first time: unique reference number, date and time record, name of the person who record the incident, method of notification, user information, description

of symptoms, activities to undertake in order to resolve the incident, etc. Other fields like category, impact, urgency, closure date and time will be filled as the incident advance in its lifecycle. In this activity, it is important that the incident manager (we will talk about this role, later) define the incident logging police for cases when the incident will be managed outside the working hours. The incident history should be updated every time relevant information is generated.

A way to establish trends for other ITSM activities from a point of view of incident management is **categorizing the incident**. Knowing the type of incident recorded is important throughout its lifecycle because the incident will be redirected to suitable support group depending of this information. However, it is possible that the incident changes its categorization at any time. At the beginning, the incident can be categorized according to its symptoms but upon a later analysis, their categorization can be more specific. Multiple categories can be assigned to a single incident. It is important that each enterprise define its own multilevel incident categorization. There exists generic guidance on the categories, but enterprises can use certain techniques in order to fit this generic guidance on a correct and complete set of own categories. This activity is considered a complex activity in the case of SMEs.

Assigning an appropriate prioritization code is another key data at the moment of logging the incident. Allocating the adequate **priority to incident** determines how the incident is handled by the support staff. Priority is a variable which depends on the urgency and impact. Urgency of the incident refers to how quickly the business needs a resolution. The impact of an incident can be measured in diverse ways: the number of users affected by the incident, if there is risk to life or limb, the number of services affected, the level of financial losses, the effect on business reputation or regulatory or legislative breaches. Some organizations include a "special priority" for some users or clients. They usually are high ranking executives, officers, diplomats, and politicians. Incidents reported by these people should be handled on a higher priority than normal. All rules about incident prioritization need to be well documented. As in the case of incident categorization, incident prioritization can change at any time in the lifecycle, every change needs to be correctly supported and reported in the incident history. This activity is considered complex in the case of SMEs.

The **initial diagnosis** is an activity where the diagnosis scripts and known error information are valuable. Diagnosis scripts are established procedures to analyze incidents and determine its solution. Frequently, person who receives the incident will try to carry out an initial diagnosis based on discovering as many symptoms as possible. In most cases, this first communication and analysis is enough to resolve an incident. An incident-matching procedure is very useful in these cases, because it provides the route to find the incident resolution in other ITIL process and it ensures that incidents are not redundantly being investigated for resolution over and over each time. An example of incident matching procedure is shown in Figure 4.11. This activity cannot be fully performed in SMEs where other ITIL processes are not being implemented.

As soon as the first line support is unable to resolve an incident, the incident must be escalated to another kind of support. **Incident escalation** can be performed in two ways: Functional and Hierarchical. Functional escalation allows referring the incident to another support group with more time or special skills. This type of escalation must be organized in a hierarchical (multi-level) way too. Hierarchical escalation works when incidents are serious, for example, an incident with high priority. This type of escalation uses the management chain and senior management chain for redirecting incidents. Rules of any type of escalation must be agreed in Operational Level Agreements (OLAs) for functional escalation and Service Level Agreements (SLAs) for hierarchical escalation. This activity can be complicated to implement when an enterprise does not have clearly defined the internal organization of its working teams. This is, members are multifunctional.

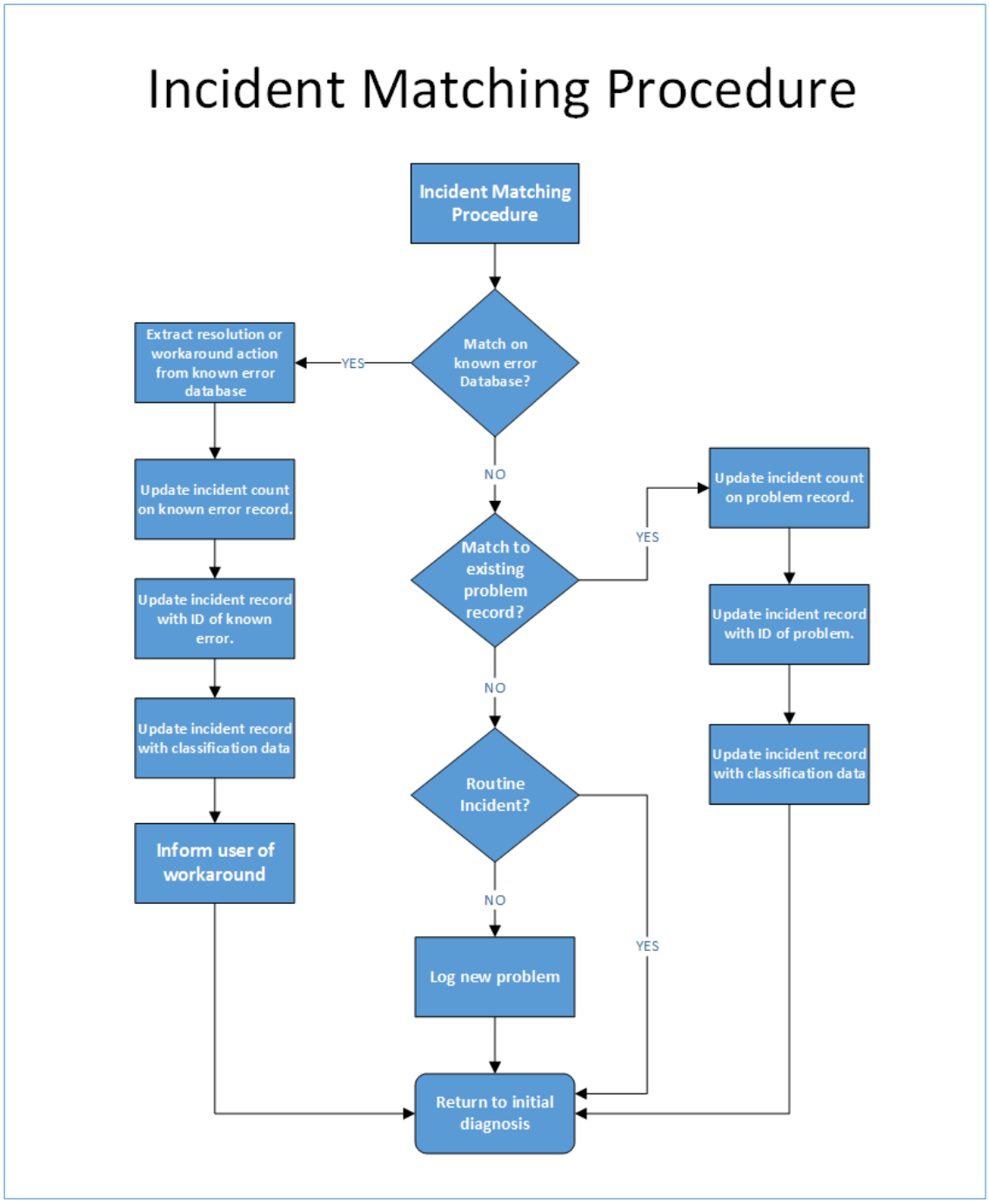


Figure 4.11: Incident Matching Procedure (OGC, 2011).

All reported incidents require some degree of **investigation and diagnosis**. Investigation can include activities as: understanding the chronological order of events related to the incident, confirming the impact and urgency of incident, and identifying all events which are triggered by the incident.

When a potential resolution has been identified, it should be tested and applied. These steps are part of the **Resolution and Recovery activity.** The implementation of a

resolution can be realized in different ways according to the nature of the incident. It will be performed remotely (using software or specific actions referred by telephone or another via) or using a third-party supplier. Sufficient testing must be performed to ensure that the recovery action is complete and the service will be restored successfully.

When the incident is fully resolved and the users are satisfied with the results, the **incident can be closed**. For this activity, 5 steps need to be performed: 1) Check if the incident categorization is right. It can be changed if it is necessary; 2) Ask to the user about their satisfaction related to the incident resolution process; 3) Review that incident history is clearly and complete at a sufficient level of detail; 4) Check if the incident is a recurring problem and redirect it to the appropriate ITIL process for a right management; and 5) Close incident formally.

Once we know more about incident management operational activities, the incident process is complete when some control activities are added. The complete process workflow is shown in Figure 4.12. Additionally, we can observe the interaction of some activities to another ITIL processes in the figure. Only one variable is missed until now: roles in incident process.

According to ITIL, four roles are clearly defined in the process. Being the Incident Manager the most important role. Driving the efficiency and effectiveness of the process is one of the responsibilities of the Incident Manager. Definition of policies, procedures or variables is headed by this person as well as continues process auditing. Also, it is responsible to produce reports and key performance indicators results. In general, the incident manager must ensure that the teams follow the incident management process flow for every reported incident. The first line of support is the second role in this process. When a service desk function is implemented, this role is assigned to it, but when this function is not implemented, this role is assigned to the team in charge of establishing the contact with the user. The second line of support represents a staff with different skills, they help to the first line of support to diagnose the incident. Finally, the third line of support is composed by the technical groups and/or third party suppliers. More support lines can be defined if it is required by the Incident Manager.

According to the enterprise, these roles can change, nevertheless, it is mandatory to assign an Incident Manager.

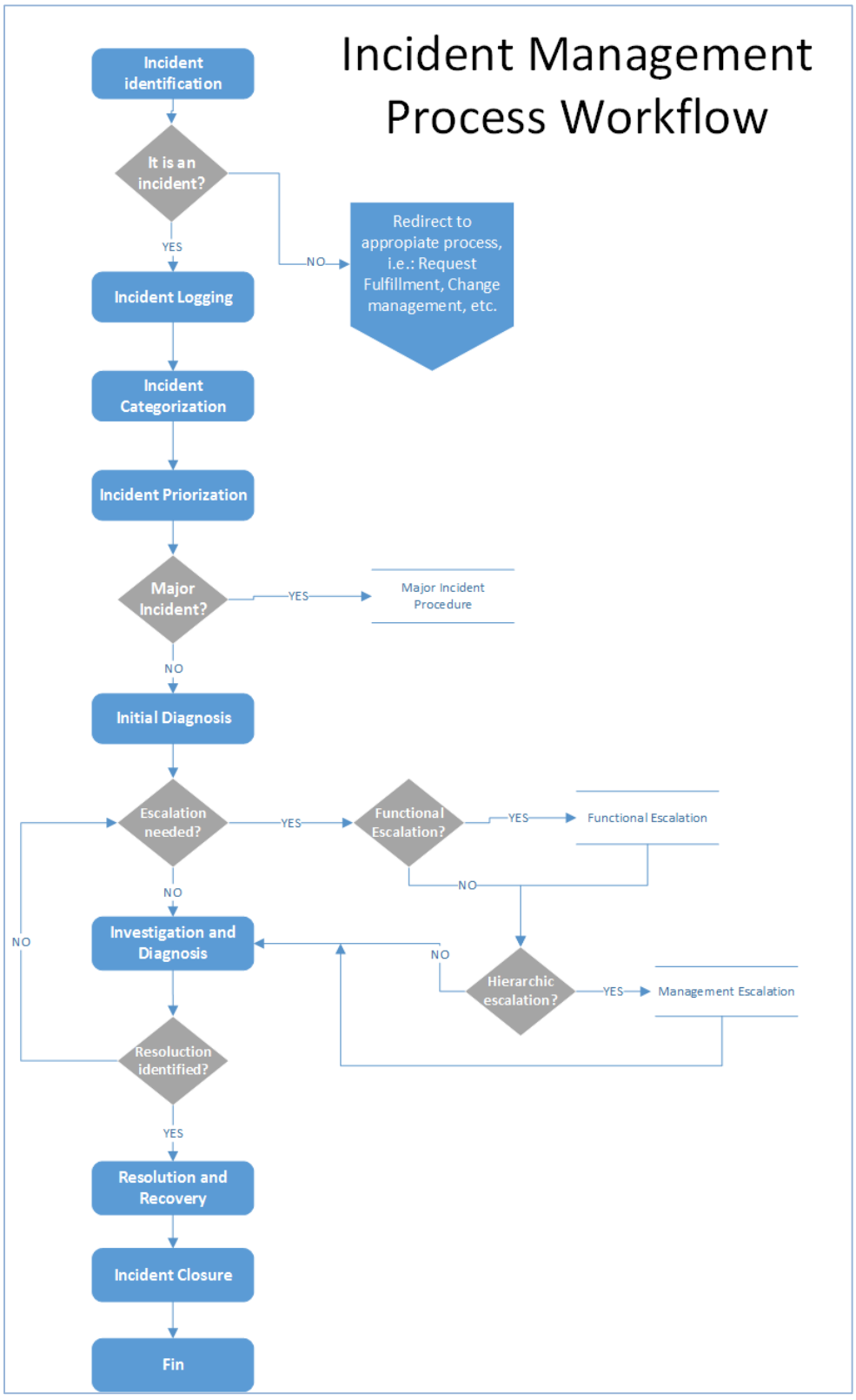


Figure 4.12: Incident Management Process Workflow (OGC, 2011).

Following table (Table 4.4) shows the relationship between each activity in the incident management process and the roles and other ITIL processes.

Activity	Role in process	Relation to other processes.
Incident Identification	All enterprise staff	*Receive input from processes:* Event Management. *Receive input from function:* Service Desk. *Activity query to process:* Service Level Management (defined SLAs)
It is really an incident?	First line support, Incident Manager (supervise)	*Event is redirect to process:* Request Fulfillment OR Change Management OR Problem Management.
Incident Logging	First line support	--
Incident Categorization	All support lines	*Activity query to process:* Service Level Management (defined SLAs)
Incident Prioritization	All support lines Incident Manager (when prioritization is special)	*Activity query to process:* Service Level Management (defined SLAs)
Major Incident?	Incident Manager	--
Initial Diagnosis	First support line	*Activity query to processes:* Knowledge Management, Problem Management, Access Management
Escalation needed?	Corresponding support line	*Activity query to processes:* Service Level Management.
Investigation and Diagnosis	Corresponding support line	*Activity query to processes:* Knowledge Management, Problem Management, Event Management, Access Management.
Resolution identified?	Corresponding support line	--
Resolution and Recovery	Corresponding support line	*Activity can updates processes:* Configuration Management, Access Management.
Incident Closure	Corresponding support line	*Activity can updates processes:* Knowledge Management OR Problem Management OR Availability Management OR Capacity Management OR Access Management

Table 4.4: Incident Management Process relationships.

4.2.1.1.3 Considerations about Incident Management Process

Nevertheless, Incident Management process provides visible results more quickly than other ITIL processes, some of its activities need to send information to other process components. The author of this thesis considers that these activities have the highest difficulty level in the context of SMEs. Hence, it is fundamental to find a novelty way to organize the activities in order to achieve an incident management implementation according to the SMEs environment and practitioner's restrictions.

4.2.1.2 ISO 29110 - Lifecycle profiles for Very Small Entities

In this thesis it has been talked a lot about the importance of SMEs in the world's economy and how some international standards cannot be adjusted in order to be implemented in a SMEs. However, there are initiatives supported by international organizations, for example: ISO has created a working group denominated SC7-WG 24 which objective is that current ISO standards be more accessible for SMEs.

The standard ISO/IEC 29110 for VSE (Very Small Enterprise) is a big achievement of this group. By means of defining common frameworks, the creation of "profiles" became a key of group goals. Profiles are defined with the purpose of building a package of references and/or parts of others documents that can help to complete the standard implementation.

This idea of building a structure based on the definition of profiles can be applicable for another standards or frameworks. ITIL can be one of them.

26 processes conform ITIL. It sounds logic that the implementation of this large number of processes should be conducted using a schema appropriate to SMEs. Processes and activities that conforms ITIL need to be schematized in order to complete the implementation achievements by steps.

The number of process activities in ITIL can vary in each process. Despite of ITIL publications describe the activities in sequence, this does not mean that the SME is prepared to implement this sequence Figure 4.13 shows a proposal of using the profile schema: process activities can be distributed in three profiles (Basic, Intermediate and Advanced). Activities can be distributed in each profile using a "difficulty level" and/or "activities dependency" as a discriminant factor.

The idea is that all ITIL processes use these three profiles to organize its implementation in a SME context.

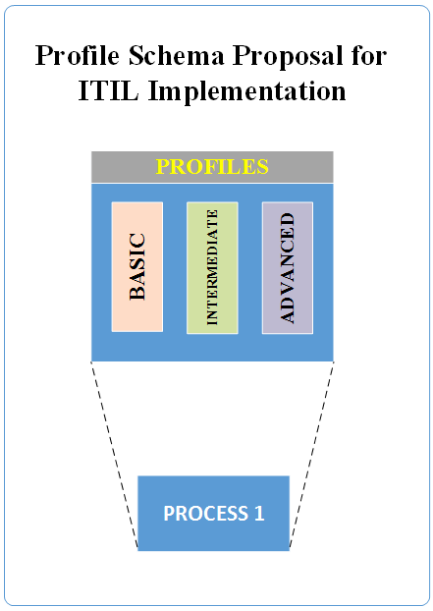


Figure 4.13: Profile Schema for Implementation of ITIL Activities

In Section 4.1.1 a short sequence of the ITIL implementation process has been defined. However, the other 23 processes have not been placed in sequence, yet. In addition to this challenge, the doubt arises: Is an implementation sequence of 26 spots a convincing and efficient way to implement ITIL? Unfortunately, the answer to this question is out of the scope of this thesis, but anyway, it is possible to propose a level schema as a solution to large implementation sequence.

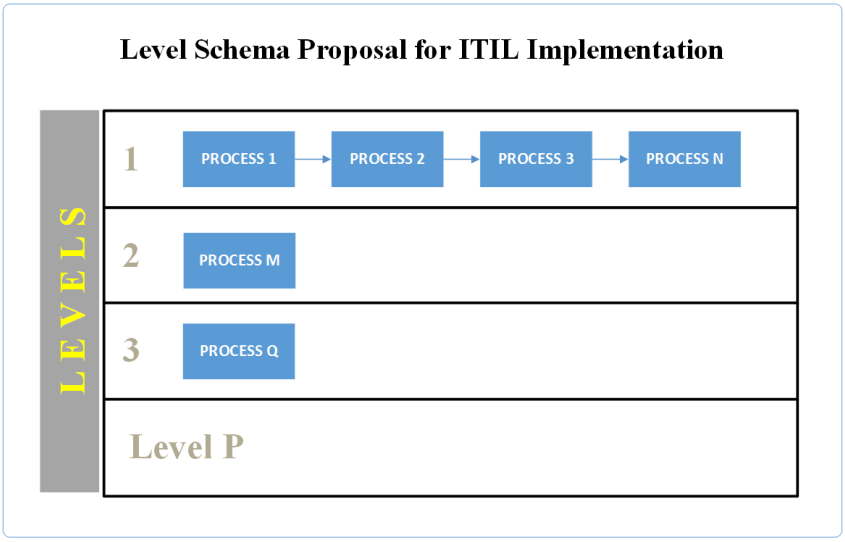


Figure 4.14: Level Schema Proposal for ITIL implementation

Figure 4.14 shows the proposal. A level schema is constructed in a vertical way. Each level is composed by a not specified number of processes (the number of level, the

number of processes is out of the scope of this thesis and the meaning of each level too). Within the level, each process must be located sequentially.

Finally, as previously mentioned, each process must be specified through its implementation strategy using the profiles schema. These two schemas (profiles and levels) conforms The Integral Resolution Idea for implementing ITIL in a SME which is shown in Figure 4.15.

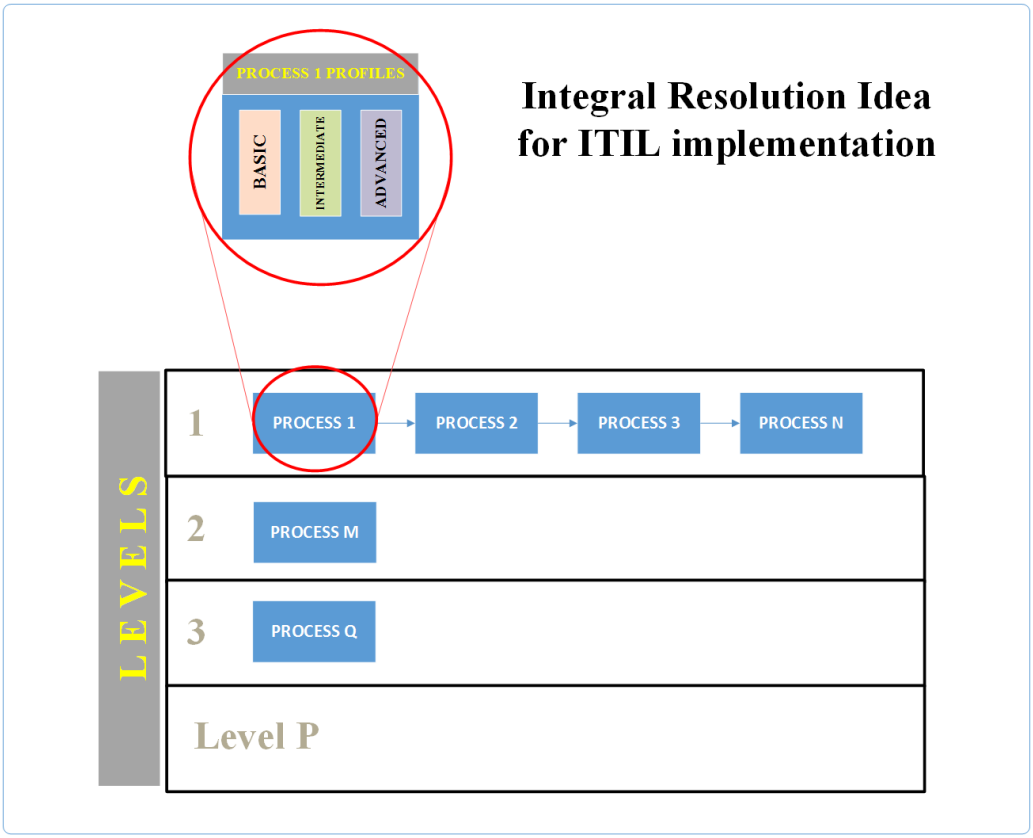


Figure 4.15: Integral Resolution Idea for ITIL Implementation

4.2.1.3 Implementation Strategy of Incident Management Process

The design of an implementation strategy of the first ITIL process which belongs to the proposed ITIL sequence is part of the research objectives of this thesis. The Definition of implementation sequence was performed in section 4.1.1 and in section 4.1.2, and literature shows that Incident Process Management occupied the first place in the implementation sequence. Thus, implementation strategy developed in this section is driven to the Incident Management Process.

But, it is important to remember that both the implementation sequence and the strategy are a little part of the resolution idea related to the ITIL implementation. In

Figure 4.16 the scope of this research work (figures with straight weft) compared to the overall idea of integral resolution proposal is presented.

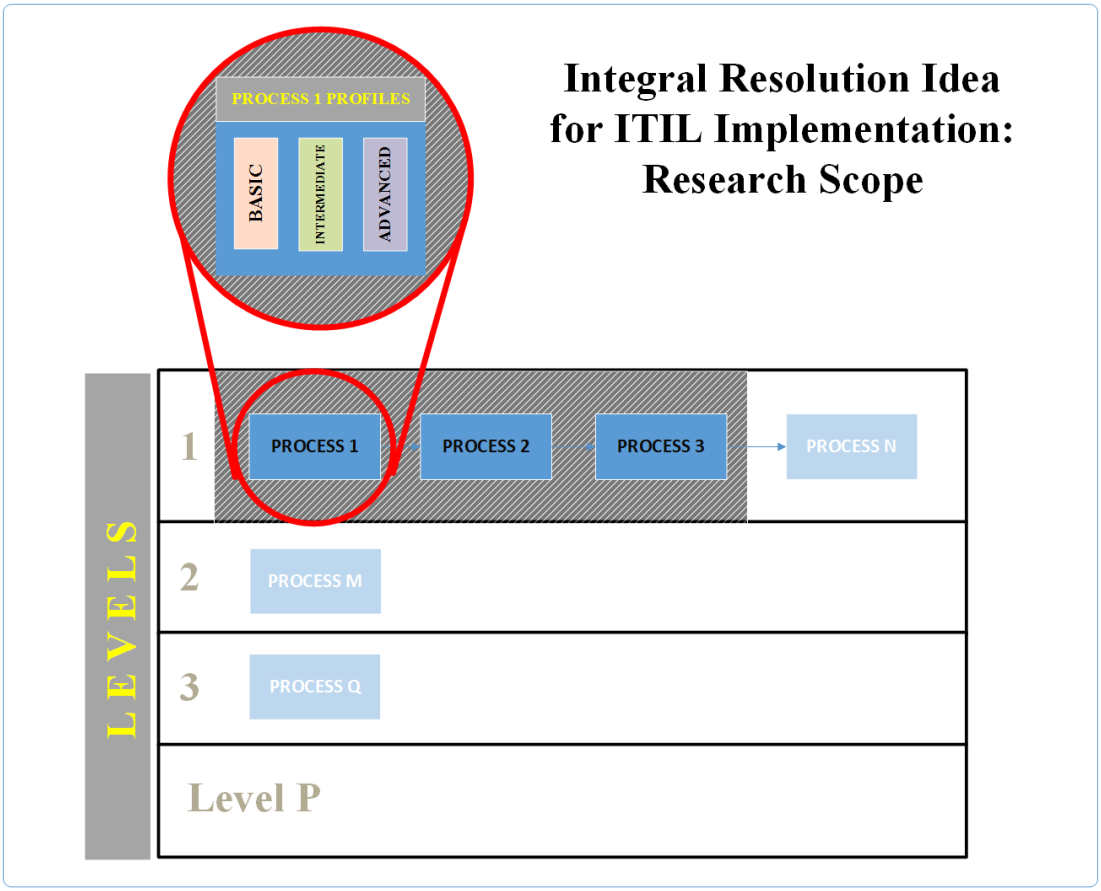


Figure 4.16: Part of the Integral Resolution Idea addressed in this thesis

Using the profiles schema, an implementation strategy for the Incident Management process has been designed. For this purpose, consultation to experts has been performed.

Consultation to experts

The delimitation process used during the survey planning described in section 4.1.1.2.1 were carried out in this consultation to experts.

The five professionals invited previously were invited again, the goal is to perform a Delphi study for ordering the activities of the incident management process according to these factors: 1) activity that is easy of being implemented; 2) activity implementation shows quick wins; and 3) dependency of activity respect to others activities within the incident process and other ITIL processes.

A scale of three options was created to grade each process activity. Factor 1 and factor 2 use the scale: ● totally agree; ◑ partially agree; ○ totally disagree. In case of factor 3, the scale was: ● poorly dependent; ◑ moderately dependent; ○ highly dependent. The score was calculated using the average of professionals' answers. Subjects took 35 minutes to agree with final results which are presented in Table 4.5 and Table 4.6. Additionally, a justification about the score related to factor 3 is presented.

Activities of Incident Management Process	**Factors**	
	Easy to implement	**Quick Win**
Incident Identification	◑	●
Incident Logging	●	●
Incident Categorization	◑	◑
Incident Prioritization	◑	◑
Initial Diagnosis	○	○
Incident Escalation	○	○
Investigation and Diagnosis	○	○
Resolution and Recovery	●	◑
Incident Closure	●	●

● totally agree; ◑ partially agree; ○ totally disagree

Table 4.5: Incident Process Activities Analysis

Activities of Incident Management Process	Activity Dependency Analysis	
	Score	Justification
1. Incident Identification	●	This is the most important activity in the process. All others activities in the process depends on it. Despite other processes can help to improve this activity, it is fundamental to start identifying incidents in a standard way.
2. Incident Logging	●	It is the activity that starts the incident lifecycle. It is fundamental and it does not depends on another ITIL process.
3. Incident Categorization	◑	Categorization can be a difficult task. According to ITIL publications, incident categories must be defined in another ITIL process.
4. Incident Prioritization	◑	Incident prioritization is a complex task when an enterprise does not have a previously knowledge about incidents. It is better to acquire data before establishing a prioritization schema.
5. Initial Diagnosis	○	The activities 5, 6 and 7 need to know more about historical incident information and behavior. Panelists consider that in the context of SMEs these activities can be very difficult to implement.
6. Incident Escalation	○	
7. Investigation and Diagnosis	○	
8. Resolution and Recovery	●	This activity allows acquiring and recording the necessary knowledge for implementing the most complex activities.
9. Incident Closure	●	This activity is easy to implement and only depends on that the activity 1 was implemented.

● poorly dependent; ◑ moderately dependent; ○ highly dependent

Table 4.6: Incident Process Activity Dependency Analysis

The compilation of results is grouped according to the profiles schema proposed in previous section. Accumulative implementation of all profiles represents the complete implementation of the Incident Management Process. This way to organize process activities is called Incident Management Implementation Strategy – IMIS and it is shown in Figure 4.17.

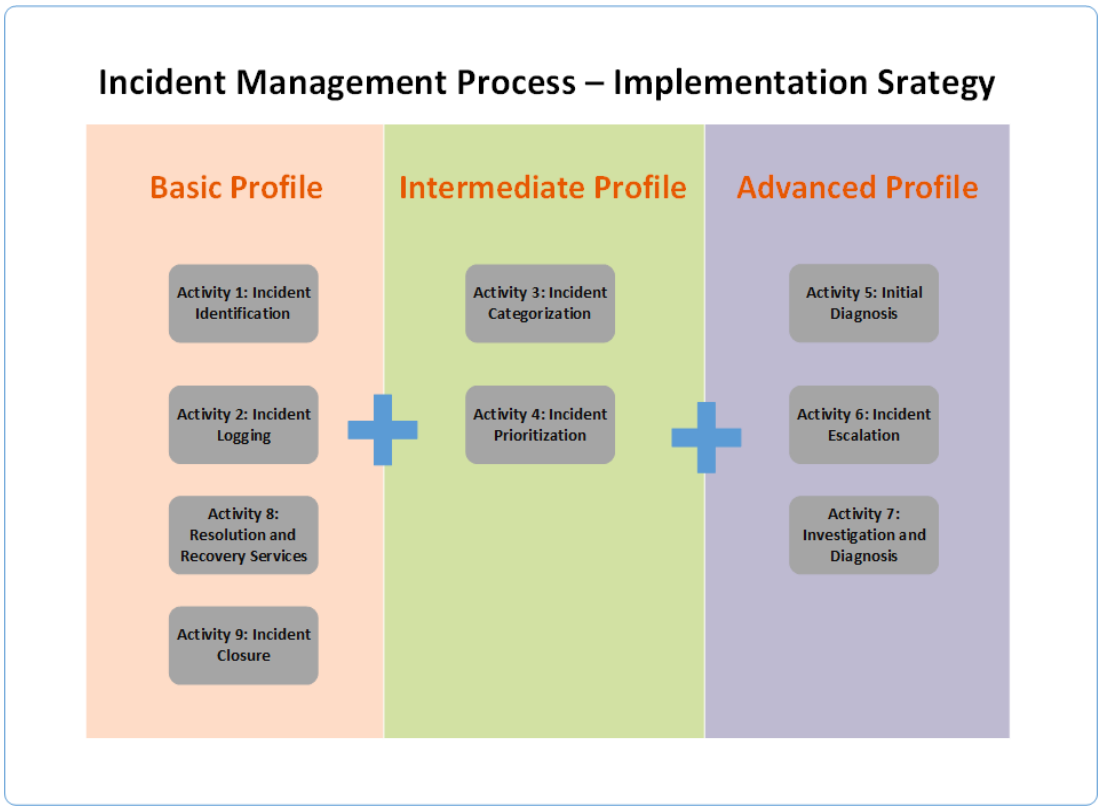


Figure 4.17: Implementation Strategy of Incident Management Process

4.2.2 Activity Five: Incident Management implementation Strategy Evaluation

Last activity in the research methodology is the IMIS evaluation. This activity consists in putting into practice the defined strategy in a real context on an Ecuadorian SME. A case study is the research methodology used for this purpose.

Context delimitation, case study plan, case study design which includes research question, and study propositions definition are described in detail in chapter five. Also, the case study deployment and results of the evaluation are presented too in chapter five.

CHAPTER 5

CASE STUDY

As a final step in the research activity process described in chapter 3, activity five denominated "Experimentation" is presented in this chapter.

First, an overview about the importance of conducting case studies in software engineering is presented and discussed. After, four subsections are used to explain the case study conducted as a part of this master thesis. Finally, a survey conducted with experienced practitioners in the case study in order to test the propositions formulated is presented.

5.1 Case Study methodology in Software Engineering

Case study methodology was used for explanatory purposes according to Flyvbjerg (Flyvbjerg, 2007). In areas like psychology, sociology, political science, social work, business, and community planning, case studies are commonly used in order to increase knowledge about the context related to a phenomenon. This goal is shared to software engineering discipline which takes the acquired knowledge for introducing an improvement approach in analyzed context (Andersson & Runeson, 2007).

By definition, case studies are conducted in real world settings, which involves a high degree of realism and the challenge to find balance with the level of control during the case study execution. The book titled Real World Research (Robson, 2002) describes four types of purposes for research: exploratory, descriptive, explanatory, and improving. Software engineering case studies tend to lean towards a positivist perspective; so they are classified as a mixture of descriptive and explanatory research type. This means that software engineering cases studies try to portray a situation or phenomenon, seeking an explanation, mostly but not necessary in the form of a causal relationship.

The design of the research process can be defined in two ways: fixed and flexible (Anastas & MacDonald, 1994) (Robson, 2002). Fixed design process, like experiments and surveys, defines its parameters at the launch of the research while in flexible designs some research parameters can be changed during the research execution. Case studies are typically flexible designs, however it does not means that the case study

conduction cannot be in a planned and consistent manner. A way to guide a case study conduction is setting specific objectives from the beginning of the study, and the objective should be refined using a set of research questions which are to be answered through the case study analysis. Also, the development of theoretical propositions to guide data collection and analysis is useful.

When talking about the kind of data that will be collected in a research, we can say that most case studies are based on qualitative data. Qualitative data involves words, descriptions, pictures, diagrams, etc. and they can be analyzed using techniques like categorization and sorting. This fits correctly when case studies are associated to software engineering discipline because qualitative data allows gaining a deeper understanding of the studied phenomenon. However, the possibility to mix qualitative and quantitative data (numbers) is possible according to (Robson, 2002) and it is also valuable for software engineering discipline. A case study will never provide conclusions with statistical significance. On the contrary, many different kinds of evidence, figures, statements, documents, are linked together to support a strong and relevant conclusion (Runeson & Höst, 2008).

Software engineering is a multidisciplinary area which involving areas where case studies are normally conducted (Runeson & Höst, 2008). This means that all previously analysis of each parameter in the research process should be adapted to software engineering case study. There exists seven questions that the researcher can answer in order to determine if the case study should be used (Runeson, Host, Rainer, & Regnell, 2012):

1. Is the researcher proposal applying a strategy in real world settings?
2. Can variables be controlled by the researcher?
3. Can phenomenon be separate from the context?
4. Does phenomenon occur in a laboratory setting?
5. Can effects take long time in appear?
6. Can effects be wide-ranging?
7. Is context important?

5.2 Case Study: Implementation Strategy of Incident Management Process

After introducing the situation and importance of case studies in the software engineering field, it is important to know if the decision to perform a case study in this master thesis is adequate. For this test, the seven questions raised for the researcher and explained in the previous section are answered and justified in Table 5.1.

Case study checking questions	Answer	Justification
1. Is the Researcher proposal applying a strategy in real world settings?	Yes	A way to know the behaviour of the implementation strategy of Incident Management Process is applies in a real SME context.
2. Can variables be controlled by researcher?	No	Researcher provides the proposed strategy and their knowledge in order to help to the ITIL process implementation. Researcher does not control the enterprise behaviour. Variables can be adjusted according to the study unit.
3. Can phenomenon be separate to the context?	No	Phenomenon is part of the daily context.
4. Does phenomenon occur in a laboratory setting?	No	Phenomenon occurs during working days in a SME.
5. Can effects take long time in appear?	Yes	Effects depends on the SME daily performance.
6. Can effects be wide-ranging?	Yes	Case study can be scaled in another research edition.
7. Is context important?	Yes	The strategy was created specifically for the context.

Table 5.1: Case Study verification questions

As we see in Table 5.1, case study fits very well to the proposal of the thesis' author: gain understanding about the use of the proposed implementation strategy of Incident Management Process in an Ecuadorian SME, from now called IMIS (Incident Management Implementation Strategy).

5.2.1 Case Study Design

Case Study design is a blueprint for a study (Runeson, Host, Rainer, & Regnell, 2012). Many elements can be defined as a part of the design; the reasons for undertaking the

study and its expectations are formally described in section 3.2, these definitions are called “Rationale for the Study” and “Objective the Study”.

In software engineering, the study of an entire software project as it progresses over time is however extremely challenging; for this reason, researchers tend to focus on some aspect of a software project for their case studies. In the context of this thesis, the case study is considered as holistic, this means that the case is studied as a whole in its global nature because it is considered a representative and typical case; also it can be used as a preparation situation for subsequent case studies. Details about unit of analysis of this case study are also detailed in section 3.2 as a part of the research methodology chapter.

5.2.1.1 Research Questions and Study Propositions

Now, in order to know about the knowledge that is being sought or is expected to be discovered during the case study; the discovery or attainment of this knowledge demonstrates that the case study has achieved its intended objectives (Runeson, Host, Rainer, & Regnell, 2012). This is possible thanks to the definition of research questions. Research questions state what is needed to know in order to fulfill de objective of the study.

Another way to direct the attention to something that should be examined in the case study is the definition of propositions. Propositions are affirmations which are claims about the defined research questions. However, definition of propositions could not be performed in some case studies. This implies that the study will be conducting as a topic of exploration.

Taking up the focus in the case study developed in this master thesis, Table 5.2 shows the research questions, sub-questions and propositions raised for the case study conduction based on the two objectives previously defined: 1) to test the implementation strategy based on profiles schema contributes to motivate the ITIL implementation initiatives in SMEs; and 2) to empirically evaluate the implementation strategy in a real ITIL implementation initiative.

Research question	Research sub question	Proposition
RQ1: Why is more adequate the use of IMIS based on profiles than the complete process implementation?	RQ1.1: How the IMIS's basic profile motivates to go further to implement next profiles?	P1: the incident identification (first activity in basic profile) has improved after putting into practice the strategy.
		P2: the incident logging (second activity in basic profile) has improved after putting into practice the strategy.
	RQ1.2: How to improve the proposed implementation strategy of Incident Management?	P3: the incident resolution and recovery (third activity in basic profile) has improved after putting into practice the strategy.
		P4: the incident closure (fourth activity in basic profile) has improved after putting into practice the strategy.
RQ2: How has changed/improved the enterprise after IMIS?	RQ2.1: How the enterprise has improved the aspects such as human resources, expenses, response times, customer impact, and impact on services and impact on staff?	P5: time to detect the incident cause has been improved.
		P6: incident resolution time has been improved.
		P7: human resources organization acquires new responsibilities.
		P8: incident resolution expenses have been reduced.
		P9: number of incidents that general manager intervened on incidents resolution have been reduced.
		P10: number of times that version need to do rollback have been reduced.

Table 5.2: Case Study Research Questions and Propositions

5.2.2 Collecting Data

In this case study, data are primary collected using interviews, focus groups, and the information recorded in the application installed with the propose to manage incidents.

Interviews were prepared in advance by the author of this thesis. Generally they were conducted in two parts: firstly with the general manager, and secondly with working teams. Focus groups usually were driven by the thesis's author with at least 1 team leaders as an attendee, general manager did not participated on them, but the information collected were corroborated by him.

Next subsection describes details about the unit of the analysis and the steps realized as introduction of the case study to the enterprise members.

5.2.2.1 Unit of Study Description

Participant enterprise or also called unit of analysis is an Ecuadorian small company composed by 20 employees. “Software Factory” is the name of the enterprise which have as a principal service the development of software solutions customized to the customer.

Internal organization of the enterprise is simple due to its size. A General Manager leads the organization and in some specific cases he acts as the team leader. Other employees are classified as team leaders and developers. The Development Teams are composed by one team leader and some developers, the number of developers depends on the project characteristics. Development teams do not have the same member of people for all projects assigned to them, developers can be alternated between development team development team according to the project and the General Manager decision. Many projects can be assigned to the teams. A graphical representation of the enterprise structure is shown in Figure 5.1. Enterprise does not have a support department. Incidents related to the projects are manage by the leader of the team. In some cases the General Manager also receives incident notifications from customers.

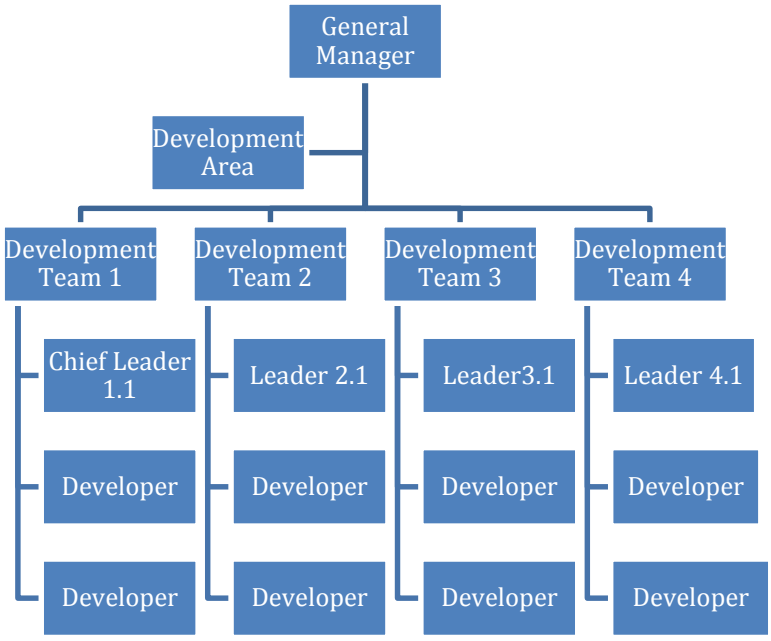


Figure 5.1: Enterprise Structure

Software is developed according to the usual lifecycle: analysis, design, implementation, testing and deployment. The team leader is responsible to the project

planning, the analysis stage (requirements engineering) and, also, he can participate in another activities of the lifecycle performed by the developers. Also, the general manager is the one who establishes the first contact with the customers, negotiates the project conditions (including deadlines); in some cases, the opinion of the team leader is taken into account at the moment of defining deadlines.

Enterprise does not provide infrastructure to its projects. A small local server is managing for internal needs of the staff. Versions are managed by each team member in their computers, and a version control system is not used by anyone. Development server does not established neither a testing environment.

In the first meeting between the General Manger and the author of this thesis, it was known that the team does not have experience in ITIL, neither in incident management. This means the enterprise does not perform any process in order to manage incidents in a standardized way.

5.2.2.2 Setting the context

With the intention to familiarize to all team members with ITIL and also in order to get more information about the actual enterprise operation and organization, some activities were carried out before starting the incident management process implementation.

First Meeting

Additionally to the activities described in Section 3.2 about the first meeting, an implementation plan was presented to the General Manager. In this plan, the activities of incident management process and its objectives are presented and also classified according to the profile assigned in the IMIS, the number of the weeks which activities can be performed is detailed too. The expectation is implementing all profiles proposed of the IMIS in the enterprise, in this manner incident management process will be fully implemented. However, its accomplishment depends on the enterprise resources, objectives and maturity. The figure of the plan is showed in Annex 3.

Planning and conduction of the second interview

Second interview objective is gathering all information about the enterprise. The interview was open, a questionnaire was prepared but open questions were realized too. Attendants to this interview were: the General Manager and the leader chief. The questionnaire was organized in three sections:

1) Enterprise information. This section includes questions about enterprise objectives/expectations, years in the market, organization, problems to resolve, and development lifecycle.

2) Services. This section includes questions related to know which are the services provided by the enterprise, its classification, service level agreements, and communication with customers.

3) Incident Management. This section includes questions about the current incident management in the enterprise.

After this interview, it could be detected that important gaps are: Services are not categorized or classified; knowledge about incidences is not the same in all team members; the current way of management incidents is disorderly and expensive (developers must to move to the customer office and stay there until the incident can be resolved; staff have information about incidents only in their emails), service desk function cannot be implemented in the enterprise (customers communicate directly to team leader assigned to their project, this relationship is important in order to start new projects and the administration does not want to change it).

Taking into account these results, it is decided to plan a training session about general ITIL information and concepts related to the incident management.

Training session: ITIL Overview and Incident Management Concepts

Training session was carried out with the attendance of all team leaders. The objective of this session is introducing an overview of ITIL and the concepts of Incident Management. The training lasted 3 hours. Concepts about events, incidents and problems were explained. Explanation of each process activity was taken specially attention. Relevant concepts as impact, urgency, and prioritization were explained

using generic definition examples. Some recommendations about the incident lifecycle and the possible analysis that can be performed using the gathering data were explained.

Focus Group: Reviewing Services Definition and Roles in the Incident Management Process

Although it is not necessary to implement other ITIL processes before implementing the incident management process, it is important that the enterprise defines a schema of the services provided. For this session, all enterprise staff attended to the session. This resulting services schema is not a formal definition as a part of another ITIL process, however it can be used as a starting point for a more formal definition. For this proposal, the thesis author created a draft proposal and it was refined by the audience. Final schema is shown in Annex 4.

Also, the role of each member of the enterprise staff in incident management process was reviewed, discussed and assigned. This definition was necessary because of the singular way which the enterprise is organized and the decision of not implementing a service desk function as a single point of contact with customers. Figure 5.2 shows the final roles assignment according to the enterprise structure presented in section 5.2.2.1. Responsibilities of each role are defined in Chapter 4, section 4.2.1.1.2. Notation of the Figure 5.2 is described after it.

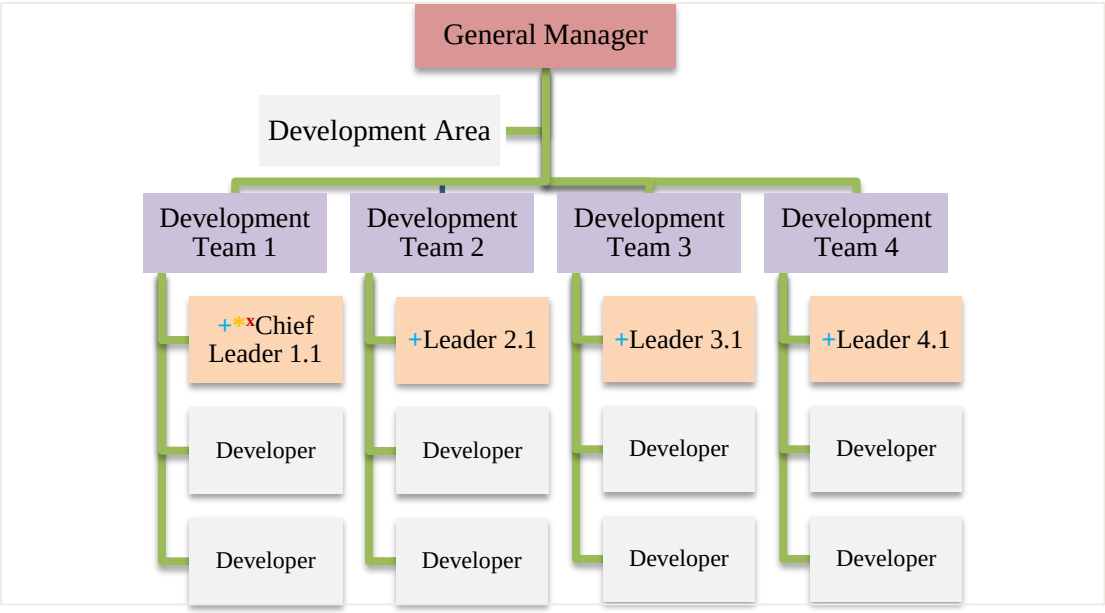


Figure 5.2: Staff Roles in Incident Process Management

The symbol (*) represents the Incident Manager role, it is assigned to the Chief leader. First support line role is represented by the light green square, all team leaders conforms this role, but their actions should be realized from a point of view of incident receptor. Second support line is represented by the symbol (+) and also it should be performed by the team leader, but acting as a requirement engineer. The symbol (x) represents the third support line, a chief leader has this responsibility. From this support line, the responsible can be moved to the customer office if it is required by the customer. Four support line is represented by the complete development team (the light orange square in the figure). Finally, the latest support line is handled by the General Manager (the light red square in the figure).

Training Session: Incident Management App

Considering that up to now, information about incidents has not been saved homogeneously in an appropriate information container; it is a key factor to adopt a right tool, which also allows monitoring and managing incident lifecycle. Selected tool is the open source web application OsTicket. An overview of the application was explained to all staff members. It was recommended that the tool is installed in a server with local and remote access. This session lasted 2 hours. One week later, application was installed and configured.

Simulation Session

Once the necessary activities were conducted in order to setting a homogenous context in the enterprise and its staff, the implementation of basic profile of IMIS can start. First, a simulation session was performed. Session lasted 2 hours. Each staff member customized its assigned role in the process and the author of this thesis acted as a customer. This exercise allowed staff to become familiar with their role in the process and, also to learn about the process's activities in order to improve its execution.

Planning Intermediate Profile implementation

In order to go forward with incident management implementation, activities of the intermediate profile of IMIS was revised. Activities of intermediate profile require two important definitions: incident categories and incident prioritizations. Two proposal

were elaborated and presented to the staff in order to make corrections and define a final version.

Focus Group: Reviewing Definition for Intermediate Profile

After 1 hour of discussion, team leaders decided that at the beginning, generic definitions of categories and prioritization are used. This decision was based on that the service classification is not the final version, so when the service definition changes, the categories and prioritization can be changed too. See the generic proposal of categories and prioritization in Annex 5 and Annex 6 respectively. Also, the general manager decides that the intermediate profile can be implemented in three weeks instead of two weeks as it was planned.

Survey B: Current State of some variables

Finally, as a part of setting context for implementation, it is important to know some measures of some variables that were taken into account in the propositions definition. For this purpose, a questionnaire was developed and filled by 6 members of the staff: 1 General Manager, 4 leaders and 1 chief leader.

Variables include in the questionnaire were: 1) time to detect the incident cause; 2) incident resolution time (after incent cause detection); 3) current staff structure for incident resolution; 4) incident resolution expenses; 5) number of times that general manager intervened on incidents resolution; 6) number of times that version rollback operation was performed; 7) number of times that the staff have to go to customer office; and 8) number of times that the reported event was reported as an incident instead of customer request. Results of this questionnaire are the following:

Question One. Detection time of the incident cause. 5 interviewers says that the team requires between 9 and 14 hours for finding an incident cause. Only one person says that it can be taken between 3 and 8 hours. Figure 5.3 shows the results.

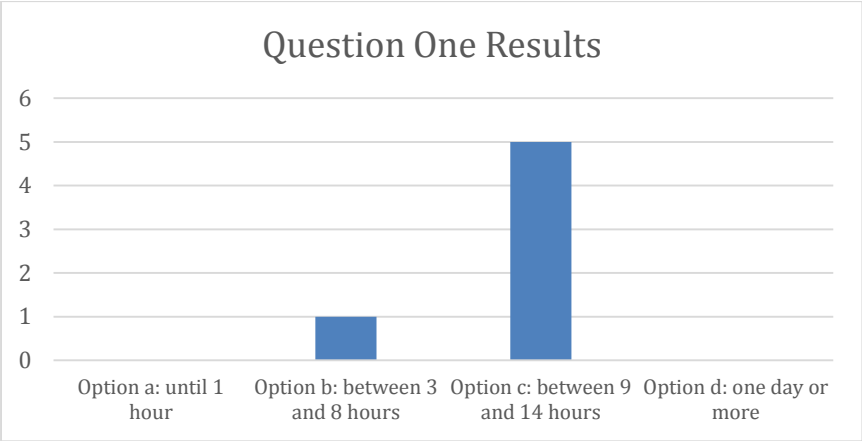


Figure 5.3: Question One of Setting Context Questionnarie

Question Two. Incident Cause usually is: Interaction between another applications fail (according to 4 interviewees), also one interviewees thinks that the cause can be raised on requirements specification inconsistence or the event could not be an incident as well as a customer request. Results are showed in Figure 5.4.

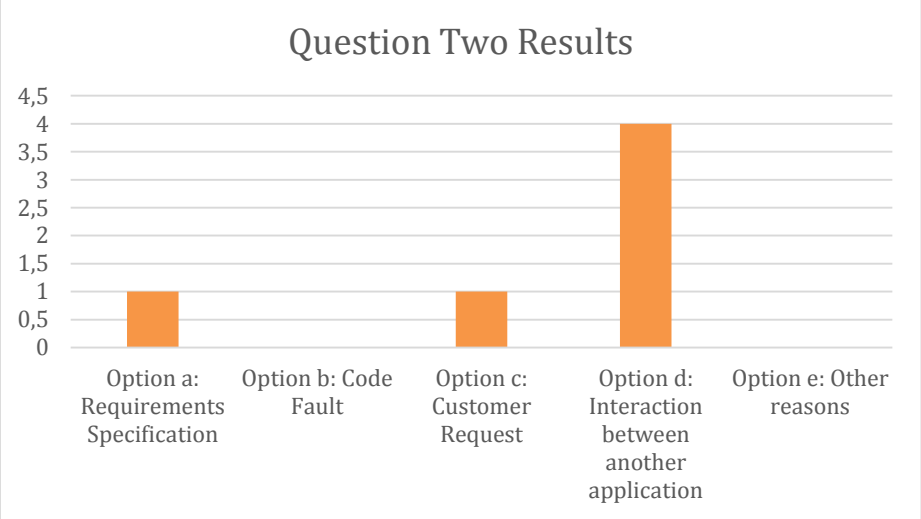


Figure 5.4: Question Two of Setting Context Questionnaire

Question Three. Relationship between incident cause and time resolution is expressed through the results of this question. Customer request incidents are the issues which are resolved by staff more quickly than another incidents causes (no more than one hour) this is because the event has been redirected to the general manager who starts a new procedure. Incidents related to "interaction between another applications" events are resolved between 9 and 14 hours according to the opinion of all interviewees. "Requirement specification" incidents and "Code faults" are resolved using the same period of time but only 5 interviewees thought in that way. See Figure 5.5

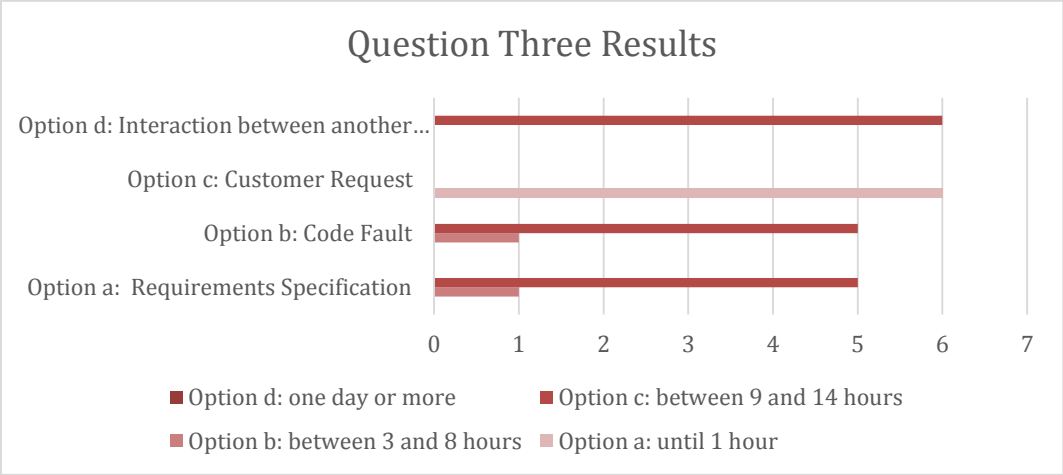


Figure 5.5: Question Three of Setting Context Questionnaire

Question Four. *About the staff organization*, all interviewees think that the current one is not adequate to managing incidents in the enterprise. They think that responsibilities can be assigned better. See Figure 5.6.

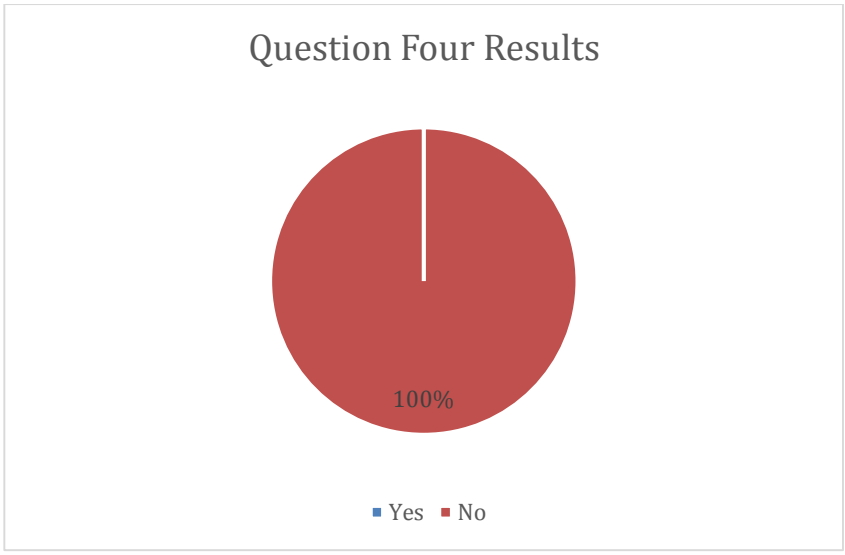


Figure 5.6: Question Four of Setting Context Questionnaire

Question Five. Incidents resolution expenses is a huge problem related to current incident resolution process. According to this questionnaire, the staff says that around 51% and 80% of reported incidents generate expenses to the enterprise because of the transportation of some members of the staff to the customer office in order to give resolution to incidents in-situ. See Figure 5.7.

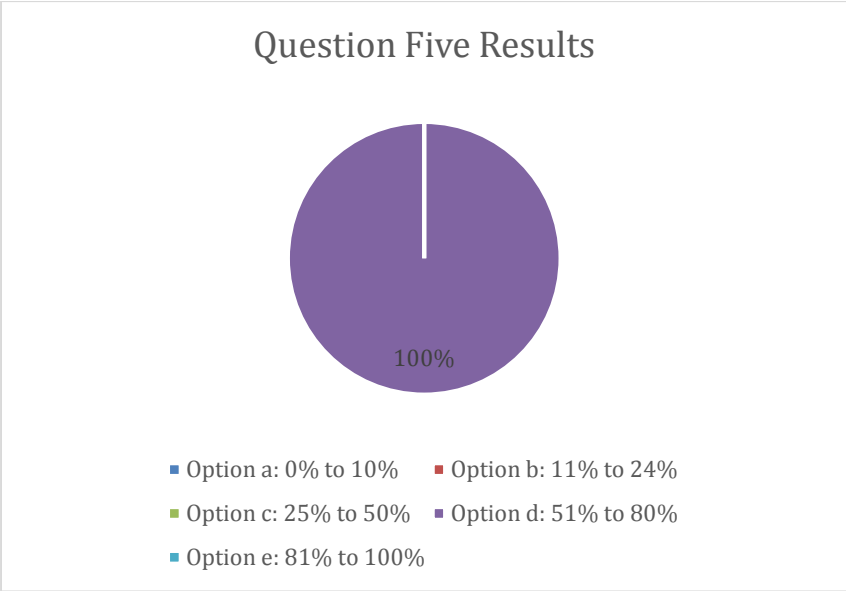


Figure 5.7: Question Five of Setting Context Questionnaire

Question Six. About the percentage of incidents which have been scalated to general manager for its resolution; the opinion of interviewees is divided between two options: one a half though that between 26% and 50% of incidents meet this premise, another half though that the percentage of incidents resolved by the general manager is between 51% and 75%. Results are showed in Figure 5.8.

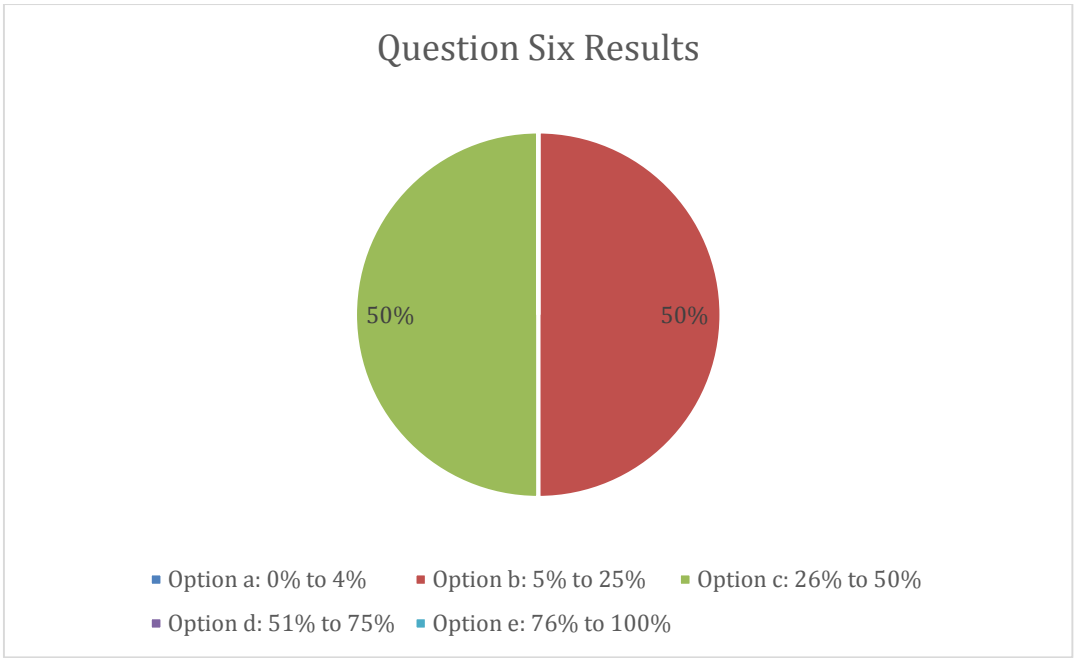


Figure 5.8: Question Six of Setting Context Questionnaire

Question Seven. Also, it is possible that as a part of the incident resolution, the service needs to go back to its previously version, according to all interviewees this situation occurs with less than half of incidents reported. Figure 5.9 shows the results.

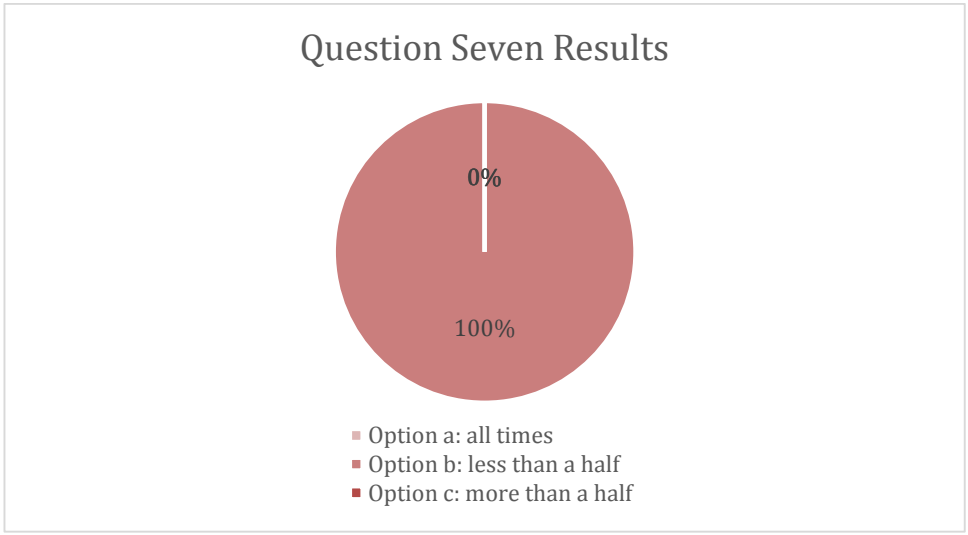


Figure 5.9: Question Seven of Setting Context Questionnaire

Question Eight. The number of times that the staff should be going to the customer office is a variable related to question five. The Question Five ensures that between 51% and 80% percent of incidents cause expenses, the same percentage of incidents need to be attended by the staff in the office customer. Both results are matched. See Figure 5.10.

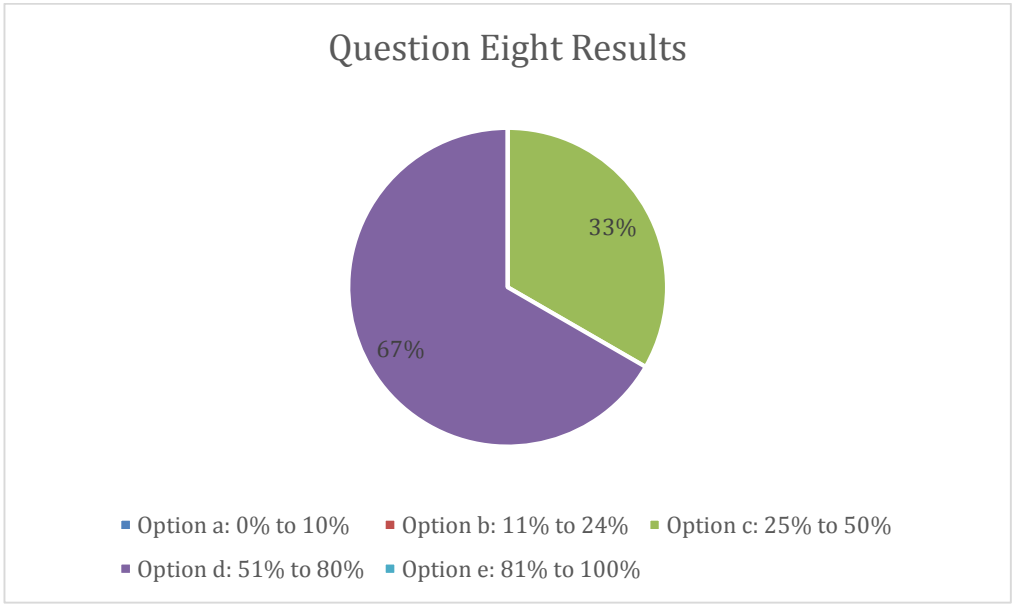


Figure 5.10: Question Eight of Setting Context Questionnaire

Question Nine. Customer can confused incidents and requests. Figure 5.11 shows that this can occur until with the 10% percent of reported incidents.

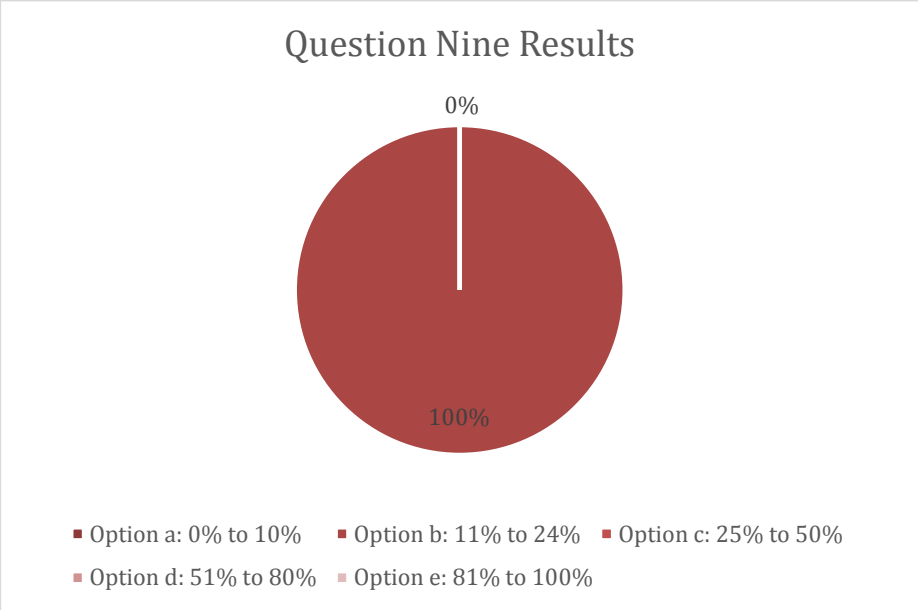


Figure 5.11: Nine Questions of Setting Context Questionnaarie

5.3 Case Study Results

The implementation strategy of incident management process was well accepted by members of the participant company. They considered that by implementing the basic and intermediate profile of the IMIS, many aspects within enterprise might be improved. These aspects are related to: staff organization and responsibilities; and reduction of expenses related to incident resolution.

Some specific situations are reported during case study conduction. They are presented in next section.

5.3.1 General Approaches

1. Implementation of the Incident Management process using a strategy based on incremental implementation of profiles was well accepted by the participant enterprise staff, who considered that this way of implementing ITIL although in short steps and quick wins, motivates SMEs to decide to start the implementation of a specific process.
2. This case study confirms the value of presenting to the enterprise a proposal which contains large and short term expectations. Despite of only one ITIL process has been implemented in the case study, participant enterprise is

interested in continuing with the implementation of the following processes of the proposed implementation sequence.

3. During implementation of the Incident Management process, the influence of an incident in the enterprise was perceived by all organizational levels. The new structure of the staff avoided that some incidents are out of control.
4. Enterprise staff noticed that management of source code using an adequate version control manager is an aspect that needs to be improved in order to reduce execution time of process activity 8. General Manager plan to introduce the use of a version tool in the next three months.
5. The use of a specialized application to monitor the lifecycle of incidents since it has been reported adds value to the information within the enterprise. The information has become a shared knowledge for all enterprise staff.
6. Staff considered adequate its role during the process, however during these weeks, it has been difficult that the different support lines not to get mixed.
7. Incidents cannot be detected early (before to be reported by customer). The main reason is that the participant enterprise does not provide infrastructure to its customers, and that means that the production environment is located in the customer side. However in order to remediate this gap, enterprise plans to negotiate with customers periodical tests in production environment. For now, incidents are known only when the customer reports them.
8. General Manager has decided that the enterprise is not prepared to implement the advanced profile. He prefers gather more information about incidents, increasing the knowledge and increasing the staff in order to create a new department that performs more activities related to deep analysis of incidents (advanced profile of IMIS).

5.3.2 The Research Propositions

Based on the findings of the case study reported by staff of participant enterprise and the second application of survey B conserving the same conditions that in the first application, the propositions defined in section 5.2.1.1 will be reviewed below.

Propositions from 1 to 4 are related to findings of the case study reported by staff of participant enterprise:

In the previous section, specifically in point number seven, it was mentioned that there exits one aspect related to the **proposition P1** which cannot be completely implemented according to ITIL publications. This situation is not presented in all SMEs, on the contrary, it is closely linked to the participant enterprise characteristics. In this case, the first activity of the process has not improved according to the expectation described in proposition P1.

Point number five in section 5.3.1 mentions the importance of information logged about incident within the enterprise. This information provided by the staff supports **proposition P2**. Definitely, the second activity of the process has improved after IMIS application.

It does not exist evidence about compliment of **proposition P3** according to the information reported by participant enterprise staff. However, in point four of the previous section, it is mentioned that the enterprise has in mind a plan to introduce tools which improve the performance of activity 8 of process.

Information reported by participant enterprise staff does not mentioned results related to incident closure activity. But, the author of this thesis considers that it is appropriate to deduce that the activity has improved because before the implementation of IMIS, the activity was not performed. This information supports **proposition P4.**

Propositions from 5 to 10 are related to the results of the second application of survey B:

Proposition P5 mentioned a possibility to improve the detection time of incident cause; this is related to question one of the survey. In this new application of survey B, results of question one shows that 50% of respondents continue considering that the detection time is between 9 and 14 hours. 33% considers option b (between 3 and 8 hours), and 17% chose option d (one day or more). This findings partially support **proposition P5**. The Implementation of the advanced profile of IMIS must improve the detection time of incidents, according to the recommendation of the author of this thesis.

Resolution time changes according to the type of causes. Respondents think that it has improved. Requirements specification causes are resolved between 3 and 8 hours; before IMIS, the average of resolution time of this cause was between 9 and 14 hours.

Resolution time of incidents related to code faults cause is improved too according to 50% of responders. Detection of incidents related to "interaction between another applications" faults are decreased after IMIS implementation, in consequence, the resolution time decrease in six hours according to 83% of responders. This findings partially support **proposition P6.**

Roles assigned to the staff are well accepted by them according to 83% of responders. This findings support **proposition P7.**

Proposition P8 is closely related to two questions in the survey B: question 8 and question 5. First, question 8 answers show that the number of times that the staff should be go to the customer office decrease (between 11% and 24%) with respect to first application of the survey B (between 51% and 80%). This means that the incident resolution expenses decrease too. This information supports the mentioned proposition.

The number of incidents that general manager intervened reduce considerably according to 50% of responders who think that this situation occurs at the most with 4% of incidents; in first survey application none of the responders believed that this would be possible. This information confirms **proposition P9.**

Finally, **proposition P10** is related to question 7 which does not change its results in this second survey application. In this aspect, the situation is further complicated due to the problems with the lack of a suitable tool to manage versions.

5.3.3 Conclusions

The results of the case study confirm that the implementation strategy based on profiles schema contributes to motivate ITIL implementation initiatives in a SME. The profiles schema is particularly useful for demonstrate to practitioners in SMEs that the best way to deal with implementation initiatives of large frameworks like ITIL is to build a strategy based on achieving quick wins for the enterprise. Moreover, practitioners involved in the implementation process perceive that the quick wins allow: 1) to know how the enterprise is reacting to implementation initiative, and 2) to decide the appropriate time to go forward or stop the implementation without a sense that the implementation has played against the enterprise.

The participant enterprise in the case study implemented the basic profile and the intermediate profile. By general manager decision, based on the quick wins achieved during the implementation initiative, the advanced profile was not implemented. This decision does not affect the achievements of the implemented profiles, on the contrary, the knowledge that is being acquired by the enterprise staff will be used to implement the advanced profile in the future. This situation is clear evidence that the profiles schema provides flexibility and security to SMEs for starting an ITIL implementation initiative. With this findings and analysis, the research question 1.1 (described in section 5.2.1.1) has been answered.

Regarding research question 1.2, the enterprise staff does not report any suggestions; nevertheless, they noticed that a way to improve the IMIS performance is taking more advantage from the settings options available on software application used in this case study.

The findings from the survey B are an evidence in order to answer the research question 2.1. Parameters as staff organization, expenses, and resolution time have a slight improvement. This is acceptable because the case study has been performed only in seven weeks. It is expected that after 2 months, the parameters increase their performance.

Taking these findings into account, as well as those from the pilot case study, survey B, and the ITIL implementation sequence, the design of the resolution idea for ITIL implementation in SMEs (section 4.2.1.2) should be continued.

CHAPTER 6

CONCLUSION

This chapter presents the conclusion of this master thesis that has addressed the problem of how to begin to implement Information Technology Infrastructure Library in small and medium enterprises. For this purpose, the activities performed to achieve the research goals and research objectives, defined in chapter one, are reviewed. Then, the research questions, also defined in chapter one, are analysed. The main contributions of the master thesis and the limitations are presented. Finally, the importance and recommendations for future research work are discussed.

6.1 Summary

This chapter presents the conclusion of this master thesis that has addressed two problems to implement Information Technology Infrastructure Library (called ITIL) in small and medium enterprises, called SMEs. The first problem is related to the necessity of SMEs for establishing good practices that contribute to maximize the capability to improve their services; and the second problem is related to find the way to begin to implement ITIL in a SME context.

The research goal of this thesis has been to contribute to the creation of a proposal for implementing ITIL in a SME environment. More specifically, this thesis aims to helping enterprises which provide services, and their employees to know how to start to carry out best practices for improving their services.

To achieve this research goal, two research objectives were formulated:

1. To propose an implementation sequence of ITIL processes to launch an ITIL initiative within a SME. A measure of success of this proposal is that it should significantly increase the interest of managers and enterprise employees to introduce a best-practice framework in a SME context.

To define a strategy for implementing the first ITIL process of the found sequence obtained in the previous objective.

To achieve the first research objective, a research methodology for building an implementation sequence of ITIL process was designed (activities one, two and three of Figure 3.1). A sequence of three processes was designed based on the findings of a literature review, specifically of the information extracted of the selected primary studies (refer to section 4.1.1.1) obtained through a systematic review, which included a list of criteria most frequently used for selecting the processes. An alternative sequence was obtained by performing survey A (refer to section 4.1.1.2). Finally, a selection of the first process in the sequence was performed (refer to section 4.1.2). The "survey A" helped to identify the most suggested tendency of the process by the literature and the most suggested processes by practitioners and experts.

To achieve the second research objective, a research methodology for developing an implementation strategy based on a specific scheme was designed (activities four and five of Figure 3.1). An implementation strategy based on profiles scheme was designed based on a deep analysis of: 1) ITIL process obtained as the first one in the sequence (incident management process). This helped to know the internal activities defined in the process, its organization, its implementation issues and the dependency between them (refer to section 4.2.1.1); and 2) the structure of the standard addressed for Systems and Software life cycle profiles and guidelines in the case of very small enterprises. This helped to introduce the concept "profiles scheme" which finally was used to design the implementation strategy (refer to 4.2.1.2). The implementation strategy or also calls IMIS, was tested in a real SME environment through a case study conduction (refer to section 5.2). A "survey B" was conducted to participant enterprise staff two times: before and after the implementation strategy deployment. The results showed the change of some interest factors to the participant enterprise (refer to section 5.3)

6.2 The research question revisited

One research question motivated this thesis: How can an ITIL implementation proposal be represented to better suit the constraints of SMEs? To focus the research work on, this research question was subdivided in six sub-questions that are discussed next:

i. What are the constraints of SMEs when they are conducting any process standard/framework/norm initiative?

The starting point to answer this question was to consider that the concept of SME can be different in some countries around the world. For this reason, definitions about SMEs in the European Union and Andean Community of Nations are reviewed. Therefore, to answer this question an analysis of this problematic is discussed in Sections 1.2 and 1.3.

Ideally, each of these found constraints should be addressed by a specific implementation proposal of an adequate standard/framework/norm.

ii. How well current process models for services in a SMEs environment work?

The literature confirmed that most of the process models for services are not created to be conducted in a SMEs environment. For this analysis, a criteria to compare process models was defined (refer to Table 2.1). Seven process models were selected to be compared according to the criteria selected. The results of the comparison analysis are shown in Table 2.2. No process meets all analysis criteria, however ITIL framework has a flexible structure that can convert it into an adequate process model to be implemented in SMEs.

The advantages of ITIL relative to other process models are focused on the freedom of addressed an implementation initiative based on the enterprise business objectives.

iii. Is it possible to implement a sequence of three ITIL processes in a SME environment?

The analysis of the primary studies obtained from a literature review showed that few ITIL implementation initiatives were performed in SMEs. However, the information about cases studies where ITIL implementation was carried on sequentially is gathered. Results of this analysis were shown in Table 2.9.

Not in all cases a sequence composed by three processes was mentioned. This indicates that the implementation of three processes is hard to large enterprises being even harder to SMEs. For this reason, we think that the proposal of ITIL implementation in SMEs needs to mark an implementation road based on quick wins for the enterprise.

vi. What would be the first ITIL process in an implementation sequence to be implemented in a SME?

The starting point to answer this question was to consider the implementation sequences extracted from two studies: information extraction of primary studies (refer to Section 4.1.1.1) and survey conduction (refer to Section 4.1.1.2). Results shown in Table 4.3 the consolidate ITIL implementation sequence proposal. Two studies agree that the Incident Management Process is the first process to be implemented. The reason of these results are rooted in the fact that Incident Management Process shows results more quickly that another ITIL process, specially from the customer point of view which is highly visible to the business.

vii. What would be the implementation strategy for the first ITIL process in the proposed implementation sequence in a SME?

For answer this question, two activities were carried on: a comprehensive analysis of the incident management process: objectives, activities, dependencies and roles (refer to Section 4.2.1.1); and structural analysis of existing standards for very small entities (refer to Section 4.2.1.2). The structural analysis has allowed learning how the incident process activities can be organized according to the approaches given by the process. This process was confirmed by consulting to an expert. The resulting strategy is expressed based on a profiles schema and it is shown in Figure 4.17.

6.3 Contributions and outcomes of this research

The main contributions of this thesis are:

1. An integral resolution idea for ITIL implementation composed by two types of schemas. First schema is the level scheme which allows a vertical layout of processes. In each level, an implementation sequence of process needs to be specified; the extension of the sequence can vary in each level. Second schema is a profile scheme. This scheme allows the organization of process activities in three profiles: basic, intermediate and advanced. The number of activities per profile can vary.
2. An implementation sequence composed by three ITIL processes. The sequence is designed according to the literature point of view and after consulting with experts.

3. A strategy implementation for the Incident Management Process. IMIS (Incident Management Strategy Implementation) was derived of two approaches: the dependency analysis of process activities and roles; and the structure analysis of ISO 29110, the standard designed for Systems and Software life cycle profiles and guidelines in the case of very small enterprises.
4. An analysis of seven process models against a set of five criteria which validated the adaptability of the processes to help to small and medium enterprises to improve customer satisfaction, performance and profitability. This analysis allows identifying ITIL as the most adaptable process model.
5. A literature review that analyses initiatives presented in scientific publications or experience reports about implementation sequence of ITIL process in enterprises of all size. Nine scientific sources were selected to perform an evaluation. At the end, nine primary studies were found as evidence.

Finally, the development of this thesis has produced outcomes that have been published in following journal and conferences:

1. "How Small and Medium Enterprises can begin their implementation of ITIL?"
   3rd International Conference on Software Process Improvement in Zacatecas, México. 1-3 October 2014. Afterwards, article was selected to be extended.
2. "How Small and Medium Enterprises can begin the implementation of ITIL?" extended version. Invitation to publish in "Revista Facultad Ingeniería de la Universidad de Antioquía" which is indexed on Web of Science database (Impact Factor: 0,070, JCR Q4, Position: 86/87).
3. "ITIL in small to medium-sized enterprises software companies: towards an implementation sequence". Article accepted in the current publication of Journal of Software: Evolution and Process (Impact Factor: 1,320, JCR Q2, Position: 32/205).

6.4 Limitations

Limitations in the study include three major aspects. First, regarding the composition of the sample of two consultation to experts; in terms of countries, number of subjects and enterprises. Second, the underlying introductory approach adopted in the study

can be reflected in the target universe of the study, software SMEs and the methods employed. Finally, the design of the study is seen as a limitation; subjects select ITIL processes without taking into account the previous implemented processes. According to Marrone et al. [11], the first process selected influences the cohort of processes adopted subsequently, so this is an important limitation in terms of research design.

6.5 Recommendations for further research work

The following paragraphs aims to motivate the undertaking of new research to build on or to develop the contributions to the knowledge generated in this thesis:

1. The integral resolution idea for ITIL implementation in SMEs can be completed. The general schema has been proposed in the thesis; however, the remaining 23 processes need to be assigned in a specific level.
2. Determining the number of ITIL processes that will conform each level in the integral resolution idea.
3. Developing an implementation sequence using the remaining 23 ITIL processes taking into account the previous recommendations.
4. Developing the implementation strategy to the remaining 23 ITIL process.
5. Expanding the composition of the sample and adopting a broader approach in the research design and through investigating specific limitations or paths present in ITIL implementations.
6. Research on interconnections between ITSM approaches with software process improvement initiatives in terms of best practices and other enablers.
7. The authors believe it is necessary to investigate ITIL implementation issues in all organizations in the software industry regardless of their size and country.

ANNEXS

7.1 Annex: Review Protocol Template

4.1. Review Planning

In this phase, it must be defined the research objectives and the way the review will be executed, which includes to formulate research questions and to plan how the sources and studies selection will be carry out. The sections of the protocol template that guide the planning phase are shown bellow.

1. **Question Formularization:** in this section, the research objectives must be clearly defined. It is composed by the following items: Question Focus and Question Quality and Amplitude.
   1.1. **Question Focus:** defines the systematic review focus of interest, i.e., the review research objectives. Here, the researcher must decide what he/she expects to be answered in the end of the systematic review.
   1.2. **Question Quality and Amplitude:** this section aims at defining the syntax of the research question (the context in which the review is applied and the question the study must answer) and its semantics specificity (or question range) described by the remaining items of this section - intervention, control, effect, outcome measure, population and application. Each one of them described bellow:
      - **Problem:** defines the systematic review target, describing briefly the research context.
      - **Question:** research question to be answered by the systematic review. It is important to highlight that, if the systematic review context is too wide, it may be necessary to decompose the research question in secondary questions to narrow the research target.
      - **Keywords and Synonyms:** list of the main terms that compose the research question. These terms will be used during the review execution (in case the search by keywords is chosen as study selection methodology).
      - **Intervention:** what is going to be observed in the context of the planned systematic review.
      - **Control:** baseline or initial data set that the researcher already posses.
      - **Effect:** types of results expected in the end of the systematic review.
      - **Outcome Measure:** metrics used to measure the effect.
      - **Population:** population group that will be observed by the intervention.
      - **Application:** roles, professional types or application areas that will benefit from the systematic review results.
      - **Experimental Design:** describes how meta-analysis will be conducted, defining which statistical analysis methods will be applied on the collected data to interpret the results. Examples of statistical calculations application for result analysis can be found in [Juristo and Moreno 2001].
2. **Sources Selection:** the objective of this section is to select the sources where searches for primary studies will be executed.
   2.1. **Sources Selection Criteria Definition:** defines which criteria are going to be used to evaluate studies sources, i.e., which characteristics make these sources candidate to be used in the review execution.
   2.2. **Studies Languages:** it defines the languages in which obtained primary studies must be written. This item belongs to this section, and not to "Studies Selection", because the chosen language may restrain the sources identification.

2.3. **Sources Identification:** this item aims at selecting sources for the review execution.
   - **Sources Search Methods:** describes how to execute the search for primary studies (for instance, manual search, search through web search engines).
   - **Search String:** case one of the selected search methods includes using keywords in search engines it is necessary to create search strings to be run at such engines. This item presents a set of logical expressions that combine keyword and its synonymous arranged in a way that highest amount of relevant studies is obtained from search engines.
   - **Sources List:** initial source list in which the systematic review execution will be run.

2.4. **Sources Selection after Evaluation:** which element of the initial sources list, must be evaluated according to the source selection criteria. If the source fits all criteria, it must be included in the final sources list, presented in this session of the protocol.

2.5. **References Checking:** one or more expert must evaluate the sources list obtained from the previous item. Case the experts find the need to add new sources or to remove some of them, the result of such evaluation must be described in this item.

3. **Studies Selection:** once the sources are defined, it is necessary to describe the process and the criteria for studies selection and evaluation.

3.1. **Studies Definition:** this item defines the way studies will be selected.
   - **Studies Inclusion and Exclusion Criteria Definition:** presents the criteria by which studies will be evaluated to decide if they must be selected or not in the context of the systematic review. It is necessary to define these criteria because a search executed in web engines may find a great number of articles that do not answer to the research question. The main reason for this to happen is that a keyword may have different meanings or be used in studies that do not deal with the systematic review research topic. Therefore, it is necessary to define what makes an article a potential candidate to be selected or to be excluded from the review. Criteria can be found in literature, as in [Kitchenham et al., 2002], or be defined by the researchers.
   - **Studies Types Definition:** it defines the type of primary studies that are going to be selected during the systematic review execution. For instance: *in-vivo*, *in-vitro*, *in-virtuo* or *in-silico* studies [Travassos and Barros, 2003]; qualitative or quantitative studies; observation, feasibility or characterization studies.
   - **Procedures for Studies Selection:** it describes the procedure by which the studies will be obtained and evaluated according to exclusion and inclusion criteria. If the selection process has more then one stage, all of them must be described. Examples of studies selection procedures are reading the article abstract and reading the full study.

4.2. Planning Evaluation

Before executing the systematic review, it is necessary to evaluate the planned review. A way to perform such evaluation is to ask experts to review the protocol. Another way to evaluate the planning is to test the protocol execution. The review is executed in a reduced set of selected sources. If the obtained results are not suitable, the protocol must be reviewed and a new version must be created.

4.3. Review Execution

After evaluating the planning, the systematic review execution can be initiated. During this phase, the search in the defined sources must be executed and the studies obtained must be evaluated according to the established criteria. Finally, the relevant information to the research question must be extracted from the selected studies.

3.2. **Selection Execution:** this section aims to register the primary studies selection process, reporting the obtained studies and the results of their evaluation.
- **Initial Studies Selection:** the search in itself is executed and all the obtained studies must be listed for further evaluation.
- **Studies Quality Evaluation:** the procedures for studies selection are applied to all obtained articles in order to verify if the studies fit the inclusion and exclusion criteria. Moreover, it must be checked if the studies belong to the types selected during the planning phase. The objective of this section is to register the results of this evaluation.
- **Selection Review:** studies selection must be reviewed to guarantee that the studies quality evaluation does not eliminate relevant articles. Here, independent reviewers may be useful. The results of the review must be recorded in this item.

4. **Information Extraction:** once primary studies are selected, the extraction of relevant information begins. In this protocol section, extraction criteria and results are described.

4.1. **Information Inclusion and Exclusion Criteria Definition:** criteria by which the information obtained from studies must be evaluated.

4.2. **Data Extraction Forms:** to standardize the way information will be represented, the researcher must create forms to collect data from the selected studies. These forms may vary depending on the systematic review's objective and context.

4.3. **Extraction Execution**: two kinds of results can be extracted from the selected studies: objective and subjective results.
- **Objective Results Extraction:** objective results are those that can be extracted directly from the selected studies. Such results must be organized as follows:
  i) **Study Identification:** studies identification includes the publication title, its authors and the source from which it was obtained.
  ii) **Study Methodology:** methods used to conduct the study.
  iii) **Study Results:** effect obtained through the study execution.
  iv) **Study Problems:** study limitations found by the article's authors.
- **Subjective Results Extraction:** subjective results are those that cannot be extracted directly from the selected studies. There are two ways to obtain such results:
  i) **Information through Authors:** reviewers contact the study's authors to solve doubts or to ask for to more details about it.
  ii) **General Impressions and Abstractions:** reviewers raise their own conclusions after the reading the study.

4.4. **Resolution of divergences among reviewers:** if reviewers don't agree on the information extracted from the studies, the divergences must be recorded. The reviewers must reach a consensus on this matter and register it in this section.

4.4. Execution Evaluation

Our experience on conducting systematic reviews showed that, during the execution phase, several problems may occur to due web search engines limitations. Each one of them deals with logical operators differently or presents restrictions on terms combination. It's not possible to identify those issues until we execute the search in theses engines.

Therefore, the systematic review process presented in this technical report suggests evaluating web search engines at the execution phase to verify if they are capable of executing the search strings previously defined during the planning phase. If there are approved, the process may go on. Otherwise, it may be necessary to exclude a digital source selected or to reform the search strings.

4.5. Result Analysis

After the systematic review execution, the results must be summarized and be analyzed using the statistical methods defined during the planning phase.

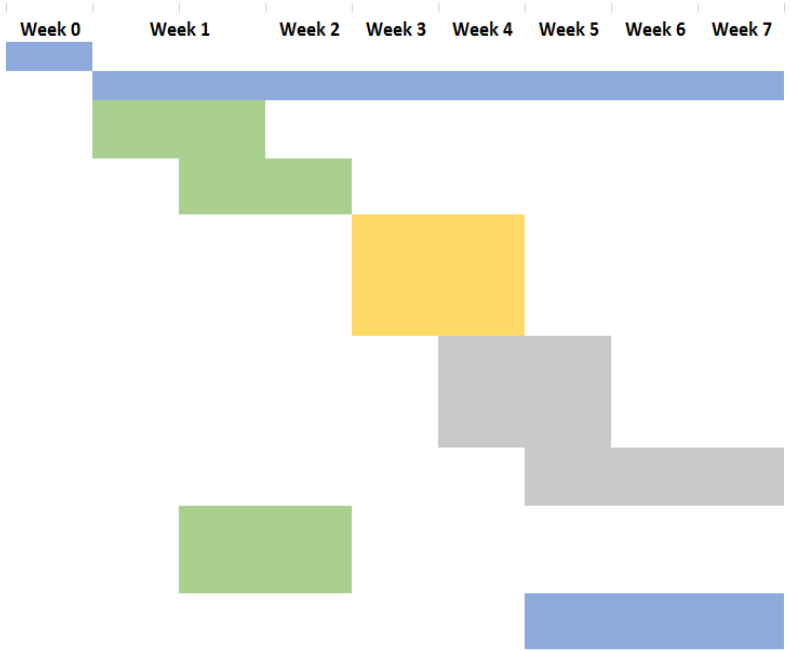
5. **Results Summarization:** this systematic review protocol section aims to present the data resulting from the selected studies.
   - 5.1. **Results Statistical Calculus:** statistical methods chosen in the "Experimental Design" section are applied to analyze data and to understand the complexity relations between obtained results.
   - 5.2. **Results Presentation in Tables:** the results obtained from the systematic review must be displayed in tables to facilitate analysis. Tables allow to classify studies according to different criteria and to organize them under different perspectives.
   - 5.3. **Sensitivity Analysis:** result robustness must be verified, investigating if there were uncertainties about including or excluding certain studies. Sensitivity analysis is more important when a complete meta-analysis is performed.
   - 5.4. **Plotting:** a data plotting strategy may be chosen to present the results. Likewise sensitivity analysis, plotting is indicated when meta-analysis is performed.
   - 5.5. **Final Comments:** this item presents reviewers final comments about the systematic review results.
     - **Number of Studies:** quantity of obtained and selected studies.
     - **Search, Selection and Extraction Bias:** if any search, selection or information extraction biases that can invalidate the systematic review results are identified by the reviewers, they must be described here.
     - **Publication Bias:** it refers to the problem that positive results are more likely to be published than negative results since the concept of positive or negative results sometimes depends on the viewpoint of the researcher.
     - **Inter-Reviewers Variation:** conflict resolution between reviewers regarding the systematic review results.
     - **Results Application:** defines how the obtained systematic review results can be applied.
     - **Recommendations:** reviewers' suggestions on how the systematic review results must be applied.

7.2 Annex: Primary Studies Information

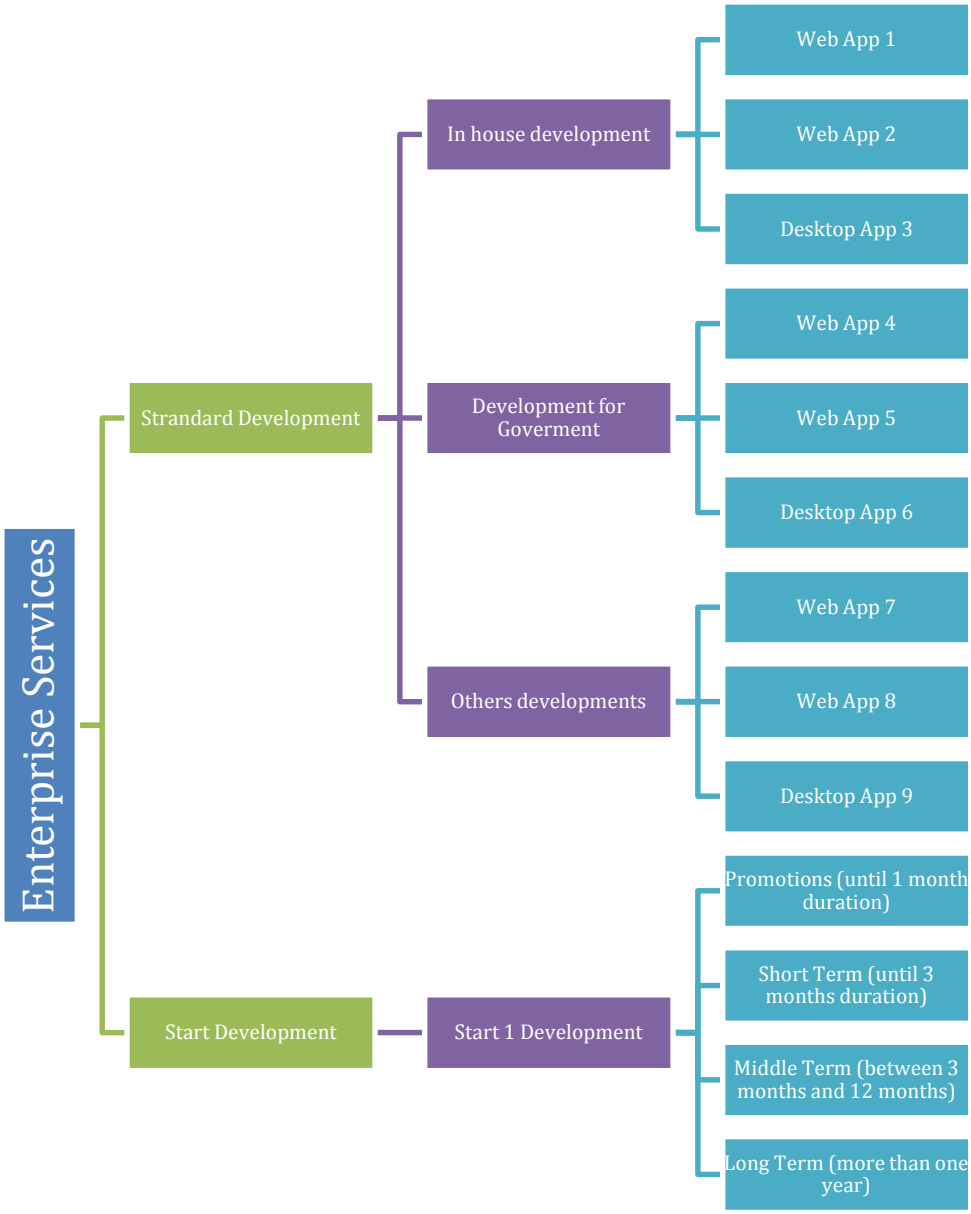
Item	Title	Authors	Publication Year	Publicado en	Pages	ISBN / ISSN
1	Adventures in change management: getting everyone on the same page	Stauffer, Greg; Scott, Rochelle	2013	SIGUCCS '13 Proceedings of the 41st annual ACM SIGUCCS conference on User services	23 - 26	978-1-4503-2318-5
2	e-government: ITIL-based service management case study	Meziani, Rachid; Saleh, Imad	2010	iiWAS '10 Proceedings of the 12th International Conference on Information Integration and Web-based Applications & Services	509 - 516	978-1-4503-0421-4
3	Implementing an ITIL-Based IT Service Management Measurement System	Antti, Lahtela; Marko, Jäntti; Jukka, Kaukola	2010	Fourth International Conference on Digital Society. St. Maarten, Netherlands Antilles.	249 - 254	978-0-7695-3953-9
4	An ITIL-Based IT Service Management Model for Garment Enterprises	Haining, Wang; Shouqian, Sun; Yanan, Huang; Shiwei, Cheng.	2008	International Conference on Information Management, Innovation Management and Industrial Engineering.	47 - 51	978-0-7695-3435-0
5	The status of IT service management in health care - ITIL in selected European countries	Alexander, Hoerbst; Werner, Ohackl; Roland, Blomer; Elske, Ammenwerth.	2011	BMC Medical Informatics and Decision Making. Volume 11.	Available online	1472-6947-11-76
6	Implementing an IT service information management framework: The case of COTEMAR	Lucio-Nieto, Teresa; Colomo-Palacios, Ricardo; Soto-Acosta, Pedro; Popa, Simona; Amescua-Seco, Antonio.	2012	International Journal of Information Management, Volume 32, Issue 6.	589 - 594	0268-4012
7	Implementation of an Information Technology Infrastructure Library Process – the Resistance to Change	Esteves, Rui; Alves, Paulo.	2013	Procedia Technology, Volume 9.	505 - 510	2212-0173
8	Business Processes Improvement on Maintenance Management: A Case Study	Abreu, João; Ventura Martins, Paula; Fernandes, Silvia; Zacarias, Marielba.	2013	Procedia Technology, Volume 9.	320 - 330	2212-0173
9	Applying an ontology approach to IT service management for business-IT integratio	Valiente, Maria-Cruz; Garcia-Barriocanal, Elena; Sicilia, Miguel-Angel	2012	Knowledge-Based Systems, Volume 28.	76 - 87	0950-7051

7.3 Annex: Plan of Incident Management Implementation Strategy

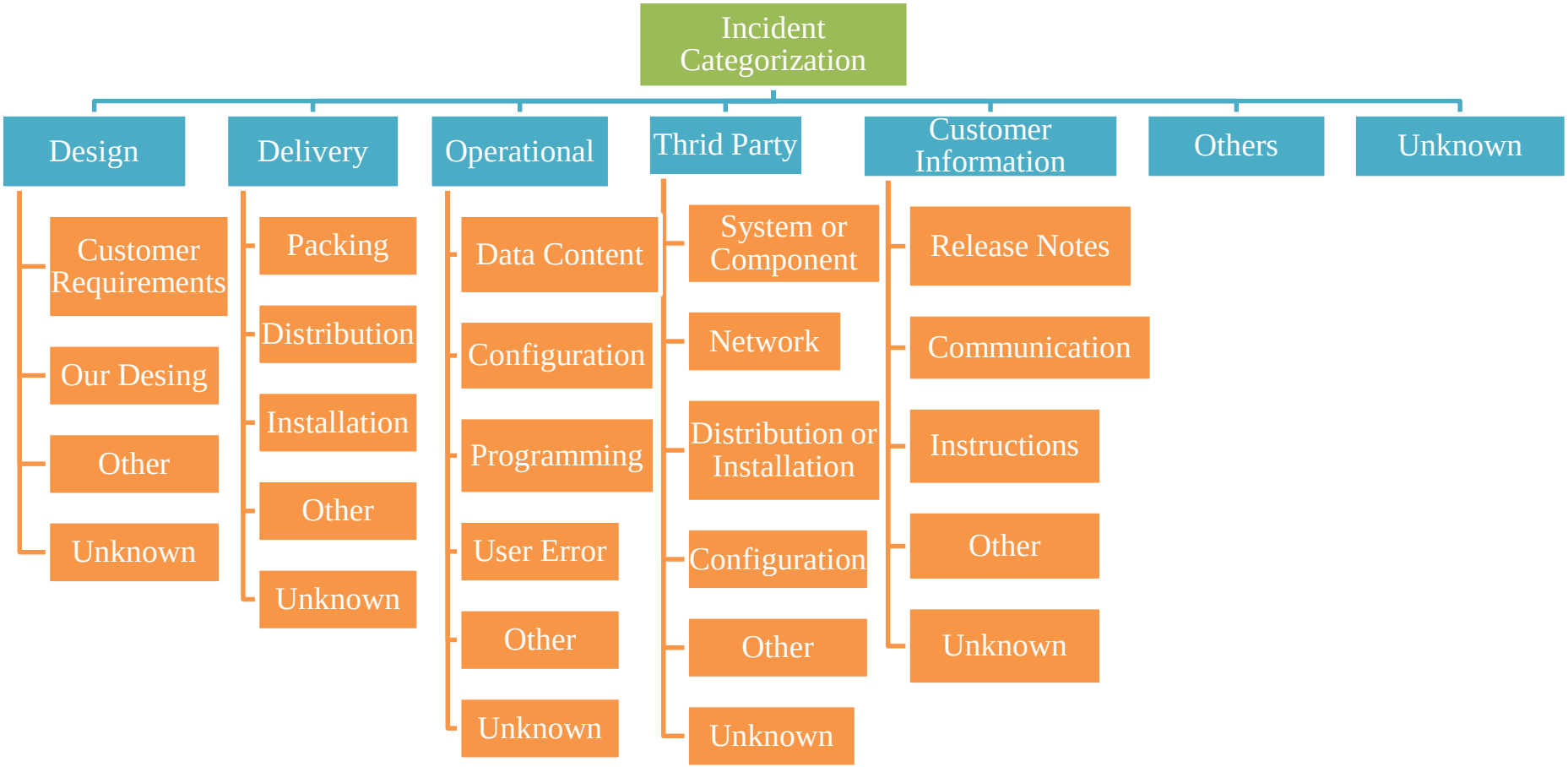
Activity	Profile	Objectives
Initial Analysis: To know thw current situation of incident management process in the enterprise (if it exists). Also, to		
Implementación de Actividades		
Activity 1: Incident Identification	**Basic**	Learning to recognize an incident understanding what the events mean.
Activity 2: Incident Logging	**Basic**	Keep a record of incidents with essential information using an open source web tool.
Activity 3: Incident Categorization	**Intermediate**	Sort the incidents for trends according to type. Categorization set according to the strategy of the enterprise.
Activity 4: Incident Prioritization	**Intermediate**	Establish a prioritization scheme of incidents according to enterprise strategy.
Activity 5: Initial Diagnosis	**Advanced**	Establish and implement mechanisms for determining early diagnoses of incidents.
Activity 6: Incident Scaling	**Advanced**	Establish and implement mechanisms escalation of incidents according to enterprise strategy.
Activity 7: Incident Diagnosis and Investigation	**Advanced**	Recognize, understand and verify the order in which the events that caused the incidents took place.
Activity 8: Incident Resolution and Restoration	**Basic**	Conduct and coordinate with involved groups in the incident resolution and evidence needed to solve it.
Activity 9: Incident Closure	**Basic**	Necessary activities for proper closure of incidents.
Monitoring and Conclusions		To follow up the entire implementation process Incident and generate a report with final conclusions.



7.4 Annex: Services Definition Schema of the Participant Enterprise



7.5 Annex: Incident Categorization Proposal



7.6 Annex: Incident Prioritization Proposal

URGENCY \ IMPACT	High	Mid	Low
High	1	2	3
Mid	2	3	4
Low	3	4	5

PRIORITY	Time to resolve [h]
1	2
2	8
3	24
4	36
5	160

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